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ASSESSMENT OF CAPTAN

FEBRUARY, 1982

Ontario

The Ontario Pesticides
Advisory Committee

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Ontario

G.S. Cooper, Ph.D.
Chairman

A.R. Chisholm
Executive
Secretary

Ministry
of the
Environment

Pesticides
Advisory
Committee

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1200 Bay Street West
2nd Floor
Toronto, Ontario
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February 16, 1982

Honourable Keith C. Norton, Q.C.
Minister
Ministry of the Environment
135 St. Clair Avenue West
14th Floor
TORONTO, Ontario

Dear Mr. Norton:

RE: THE ONTARIO PESTICIDES ADVISORY COMMITTEE'S "ASSESSMENT OF CAPTAN, FEBRUARY, 1982"

Attached please find the above mentioned report for your information and action, if such is deemed necessary.

Your Advisory Committee has spent considerable time, thought, and effort in the preparation of the document. On Monday, February 15th, 1982, the members present at a special meeting, voted unanimously to accept the recommendations that are included in the document, as well as the other sections of the report.

For your information, the following members were present at the meeting:

Dr. R. Frank	Ontario Ministry of Agriculture and Food
Dr. C. R. Harris	Agriculture Canada
Dr. L. F. Smith	Ministry of Health
Dr. G. R. Stephenson	University of Guelph
Dr. C. D. Fowle	York University, Wildlife Biology
Dr. R. Carrow	Ministry of Natural Resources

Mr. R. A. Cameron	Vegetable and Beef Grower
Mr. J. C. Ingratta	Food Processing Industry
Dr. G. S. Cooper	Chairman

Voting "Yes" on the recommendations and summary by proxy:

Mr. E. F. Muir	Fruit and Vegetable Producer

Absent from the meeting:

Mr. A. H. Gartner	Structural Exterminator - (in hospital)
Dr. D. Harding	Ministry of Labour - (on vacation)
Mr. F. C. Taylor	Fruit Grower and Vendor - (on vacation)
Dr. F. L. McEwen	Vice-Chairman, University of Guelph (Dr. McEwen removed himself voluntarily from all captan discussions as he is a member of the Consultative Committee reviewing captan.)

Thanking you for your consideration of this matter, I remain,

Yours very truly,

G. S. COOPER, Ph.D.
CHAIRMAN
G S Cooper
GSC/gm

encl.

THE

ONTARIO PESTICIDES ADVISORY COMMITTEE

ASSESSMENT OF

CAPTAN

FEBRUARY. 1982

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FEBRUARY, 1982.

ONTARIO PESTICIDES ADVISORY COMMITTEE

RECOMMENDATIONS ON CAPTAN

As the Ontario Pesticides Advisory Committee's review and assessment of the available scientific information concludes that captan poses no immediate hazard to the natural environment or to human health, the following recommendations are made by the Committee:

1. No further regulatory action be taken against captan at this time.

2. The monitoring and assessment of new research, as it becomes available, continue, and that an annual assessment of captan be carried out.

3. The recommendations of the Consultative Committee on captan or any changes in the registration status of captan implemented by Agriculture Canada be assessed for any necessary action by the province.

4. In its continuing review process, Health and Welfare Canada should review the current residue tolerance levels on captan for both Canadian grown and imported produce.

5. Agriculture Canada be responsible for the recall and disposal of all captan products should it cancel the registration of captan.

ONTARIO PESTICIDES ADVISORY COMMITTEE
SUMMARY POSITION ON CAPTAN

Captan is a multi-use fungicide that has been used over the last thirty years to control fungi and other parasitic plant diseases. It plays an important role in agricultural, forestry, horticultural, domestic, and industrial endeavours. Currently, Chevron Chemical Company and Stauffer Chemical Company manufacture captan in the United States for wholesale distribution and/or formulation to licenced vendors in Ontario.

It is estimated that 300,000 - 400,000 kg. of the active ingredient captan are used per annum in Canada. Approximately 50% of the total is used in Ontario. Of this, agricultural use accounts for about 84%, industrial use less than 10%, domestic and horticultural use 5%, and 1% in forest management.

In Canada, Agriculture Canada plays the primary role in the control of pesticides and their uses through the administration of Pest Control Products Act.

The conditions under which pesticide products are to be sold and used are set forth in a registration use pattern of each active ingredient. The registration procedure for each product is extremely complex, and takes into consideration the data on efficacy, residues, tolerance levels and environmental impact, reflecting differences in soil, climate, use areas, and cultural practices. The hazards associated with the formulating, using, and the hazards to non-users and non-target areas or organisms are assessed. Notes on toxicity, handling, and disposal are reviewed. The health aspects include exposure routes, sub-clinical effects, residues, and tolerances for food. Also, tissue storage, metabolism, reproduction, teratogenicity, mutagenicity and carcinogenicity are considered.

The goal of this process is to establish an acceptable use pattern for each active ingredient, and to set forth the conditions under which products may be sold and used. This information is incorporated into the label to assist in the safe and effective use of the product by handlers and users.

The Ontario Pesticides Advisory Committee (O.P.A.C.), through its scientific review and assessment, is extremely beneficial to the administration of Ontario's pesticides control program. The Committee, consisting of members engaged in many different scientific disciplines and drawn from universities, agriculture, industry, and provincial ministries such as Agriculture and Food, Health, Labour, and Natural Resources, annually reviews the content and the operation of the Pesticides Act and Regulations, and may recommend changes, if such are necessary, to the Minister of the Environment. It enquires into, and considers, any matter the Committee members consider advisable concerning pesticides and/or which has been referred to it by the Minister. All publications of the Province of Ontario respecting pesticides are reviewed. The Committee recommends the classification of all pesticide products under the Act. It also administers a research funding program related to pesticides and the control of pests.

In Ontario, the Ministry of Agriculture and Food has established a number of expert committees to review findings on pesticide use from research conducted within the province and compares these with the claims on the label. These committees are made up of federal and provincial government officials, researchers, and university scientists. The Crop Protection Committee and its affiliated sub-committees reviews the data and makes the appropriate recommendations suitable for the production of food within the province. The recommendations appear in annual publications for both commercial growers and home owners.

In these publications considerable information of an educational nature is given on the safe use of pesticides, emergency procedures following an accident, re-entry into treated areas, and details on application procedures. The interval between application and harvesting of treated crops is stressed to ensure that pesticide residues on marketable produce are well below tolerance limits set under the Food and Drug Act and Regulations. In order to assure that the recommendations do meet the claims and the use of pesticides are not abused, the Provincial Pesticide Residue Testing Laboratory monitors domestic produce, making available its findings, and ensuring that Ontario produce can be exported and meet the tolerance limits set by any country in the world.

A large field staff is involved in extension education that includes the recommended safe use of pesticides in the production of plant and animal products. The present policy is to extend integrated pest management programs that include more effective use of pesticides. Up-to-date information on a day-to-day basis is available to pesticide users by pre-recorded telephone messages (code-a-phone), news media, news letters, public meetings, and personal contacts.

In Ontario, the Ministry of the Environment administers the Pesticides Act, which allows for greater control on sales and use of pesticides in the province. The federal and provincial pesticides control programs compliment each other, and are well integrated. The Pesticides Act regulates the distribution, transportation, storage and use of pesticides in the Province. Each individual must exercise responsibility in the handling and application of the products for his own safety, the safety of those around him, and for the safety of the environment.

Ontario has developed and implemented extensive regulatory and educational programs with regard to all pesticides. All pesticide products sold in Ontario must be classified and assigned to a schedule, and the subsequent marketing and use of each product must be in accordance with the regulations relating to the classification. A pesticide, before being classified, must be registered under the Federal Pest Control Products Act. The Ontario classification system channels products into areas where they are required, and into the hands of applicators who are trained in the safe and effective use of pesticides. Licences are required to sell pesticide products. Licences are also required to operate an extermination business and to perform land, water, and structural exterminations. Applicants for extermination business and/or exterminator's licences are supplied with extensive study and resource materials. The applicants are required to pass an examination before licences are issued. In addition, permits are required in a number of situations which include the use of restricted pesticides, the aerial application of certain pesticides, and the use of any pesticides by an individual not otherwise licenced or allowed to do so under the Pesticides Act.

The licencing of individuals and the issuance of permits provides for the proper application of pesticides according to acceptable use patterns. In addition, prohibitory clauses exist under the Pesticides Act to correct the misuse of pesticides, primarily through the issuing of stop orders, control orders, and the imposition of fines. Routine field programs ensure compliance with the Pesticides Act and Regulations, and keep Pesticides Control Officers aware of individual and group problems so that they may be solved. The pesticides control program is supported by an extensive public information and educational program.

In Ontario, the Ministry of Labour administers the Occupational Health and Safety Act, RSO, 1980, Chapter 321 and regulations with specific health and safety provisions for industrial establishments, construction and mines, and mining plants, as well as a regulation for lead. The Act is designed to protect workers against health and safety hazards in the workplace.

The Act applies to all Ontario workplaces except private homes where work is being done by the owner, occupant or servants. It does not apply to farming operations, teachers and academic staff in universities and related institutions unless made to do so by regulation.

In Ontario, the following groups of workers involved with pesticides, including captan, are covered under this Act:

1. Transport workers involved in the distribution of pesticides.

2. Workers involved in warehousing, formulating or mixing, and packaging.

3. Those involved in handling pesticides in the warehouse, retail outlet, and distribution centers.

4. Application of pesticides by licenced exterminators, including provincial government agencies, provincial crown corporations, and local municipalities. Farm applicator contractors and farmers engaged in applying pesticides as part of farming operations and their respective workers are exempt from this Act. Farming operations include planting and growing of crops, trees (excluding reforestation) or the raising of animals.

The Occupational Health and Safety Act is administered by the Ministry of Labour's Occupational Health and Safety Division. This Act is based upon the principle that hazards can best be dealt with within the workplace itself through communication and co-operation between employers and workers.

Fundamental to this Act is the concept that employers and workers must share responsibility for occupational health and safety, and that both must actively seek to identify hazards and develop responses to protect workers. This internal responsibility system assumes assessment of the system itself by employers and workers through the appointment of health and safety committees and representatives, and through regular inspections of the workplace.

The Occupational Health and Safety Division provides consultative services to assist employers and workers in establishing and maintaining their internal responsibility systems.

Division staff conduct inspections and investigations to ensure that health and safety of workers are being protected, and that the provisions of the Occupational Health and Safety Act are being complied with. Division staff also visit workplaces to make assessments of hazardous agents which are known to be present, or where an unidentified agent appears to be creating a health hazard. Health hazard assessments are made routinely in many workplaces, but may also be requested by employers or workers. The ministry hygienist conducting the assessment is accompanied by a ministry inspector, an employer, and a worker representative.

An important aspect of the pesticides regulatory control programmes is the liaison with other provincial, federal and international agencies. This assists us in keeping abreast of new technology and scientific developments.

In Ontario extensive research programs are funded and relate to multi-discipline scientific investigations into pesticides and the control of pests, the impact of pesticides on the natural environment, human health, and integrated pest management. These programs are directed by key agencies such as the Ministries of Agriculture and Food, Environment, Health, Labour, and Natural Resources and this Committee.

There are two processes that have focused attention on captan. The first was the issuing of a "Rebuttable Presumption Against Registration (RPAR) for captan by the U.S. Environmental Protection Agency (EPA), and the second, the inclusion of captan on the list of Industrial Biotest Laboratories (IBT) compounds by Health and Welfare Canada and the United States Environmental Protection Agency.

The RPAR review stemmed from possible concerns in the areas of mutagenicity based on the results of a number of short-term in-vitro tests indicating mutagenic potential and oncogenicity based on one study revealing the formation of duodenal tumors in mice fed very high levels of captan (8,000 - 16,000 ppm). Captan, although listed as an IBT compound, has been considered separately to the regular IBT review pending a special review by the newly formed federal Consultative Committee.

The O.P.A.C. conclusion, based on the scientific assessment of the available data related to the impact of captan on the natural environment at this time, is the following:

1. Captan has no demonstrated harmful effects on water, fish, soil, soil micro-organisms, birds, or other forms of wildlife.

2. There is no evidence of bio-accumulation of captan in the environment, or adverse effects to the natural environment.

3. Captan is rapidly hydrolyzed by water and degrades quickly in the soil.

4. Residues of captan on fruit crops grown in Ontario have been found to be well below the tolerance levels established by Health and Welfare Canada, and no residues have been found in grains and vegetables.

5. Captan residues on food commodities are surficial, and are substantially removed or degraded by natural rainfall.

A further O.P.A.C. scientific review and assessment of the available data of the impact of captan on human health concludes that, at this time:

1. Captan does not present an acute oral or dermal toxicological problem.

2. As previously mentioned, a number of short-term tests using unicellular organisms in vitro show captan to be mutagenic. Where captan is deactivated by gastrointestinal juices or is exposed to whole blood prior to utilization in similar tests the results are negative.

3. There is one chronic feeding study in which there appears to be a dose response relationship when duodenal tumors developed in mice fed at high levels of captan (8,000 and 16,000 ppm). However, this was not demonstrated in an identical study with rats. The mouse may not be the best test animal to use in such chronic toxicological studies because of possible physiological overburdening of the system and its particular susceptibility to tumor formations.

4. Scientific evidence supports the fact that, in humans, captan is readily detoxified in the gastrointestinal tract and blood system, and that residues of captan and its metabolites do not persist in the body.

5. In vivo animal studies showed no chromosomal aberrations or mitotic inhibitions.

6. No teratogenic effects have been shown by various birds and mammals when exposed to captan administered by inhalation, orally or by subcutaneous injection.

7. Stauffer Chemical Company reports that an epidemiological study of workers engaged in the manufacture of captan from 1954 to 1976 showed no increase in cancer rates among workers compared to national, state and local cancer mortality statistics.

8. No fetotoxic effects have been demonstrated by birds and mammals in the absence of maternal toxic effects when exposed to captan.

9. Residues of captan on fruit crops grown in Ontario are well below the tolerance levels established by Health and Welfare Canada. Any residues present can be further reduced by washing, food preparation and cooking. No residues have been found on vegetables and grains. This minimizes human dietary exposure.

O.P.A.C.'s review and assessment of the available scientific information concludes that captan poses no immediate hazard to the natural environment or to human health. The Committee recognizes that there are several studies in progress, the results of which are expected to be available in the near future. The Committee will take these results into account when they become available.

EPA does not plan to take action at this time and is awaiting the results of a replacement study to be completed by late 1982. EPA has, together with the World Health Organization (WHO), recently increased tolerance levels for certain food commodities.

In O.P.A.C.'s opinion, the three recommendations made by Health and Welfare Canada requesting domestic cancellation of captan, establishment of a 0.1 ppm residue tolerance level on food produced in Canada, and increased provincial regulatory programs are not justified at this time.

CAPTAN

CURRENT RE-EVALUATION

FEBRUARY, 1982

ONTARIO PESTICIDES ADVISORY COMMITTEE

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CURRENT SUMMARY OF CAPTAN

There are two processes that have focused attention on captan. They are the placement by the U.S. Environmental Protection Agency (E.P.A.) of captan on the Rebuttable Presumption Against Registration (R.P.A.R.) and the inclusion of captan on the list of Industrial Biotest Laboratories compounds by Health and Welfare Canada and E.P.A.

1) RPAR REVIEW OF CAPTAN

In August 1980, E.P.A. issued a statement placing captan under the Rebuttable Presumption Against Registration process (RPAR). This is a process used in the United States to re-evaluate older pesticides and to bring these up to present-day standards. A review of the RPAR deposition reveals that the deposition was initiated because of some major concerns held by E.P.A. at that time. These concerns were in the fields of possible mutagenicity and oncogenicity. The fear that captan may be a mutagen arose from the many positive short-term tests which utilized unicellular organisms (Ames tests), moulds, fungi, *Drosophila* and *in vitro* vertebrate cells for testing. The oncogenic concern arose from a report from the National Cancer Institute (N.C.I.) that indicated tumor formation in the duodenum of mice fed very high levels (8,000-16,000 ppm) of captan in their daily diet. This has been confirmed by additional testing, but only at very high levels. These rates did not produce tumors in rats or other test animals.

Positive short-term tests which had been reported from time to time to the World Health Organization (W.H.O.) by various research workers lead to the establishment of new tolerance limits for captan in 1974. A review of new data was made by toxicologists in 1977, and again in 1978. The same residue limits were again issued by W.H.O., indicating that after reviewing the new data no changes were warranted. In 1980, after another review, W.H.O. recommended that, based on new data, the maximum residue level for captan on cherries and potatoes be increased to cover both pre and post- harvest uses of the product. The E.P.A. in October, 1981 also established new tolerances for captan and its metabolites in fat, meat and meat by-products of pork and beef.

Recent communications with Mr. J. Roelofs, Office of Pesticides Programs, External Affairs Unit, E.P.A., indicated that there was no longer the great concern regarding captan that existed in 1980. It was learned that, upon the advice of their Scientific Advisory Panel, any decision and conclusive action await the completion of two long-term studies currently underway. It is expected these tests will be completed in early 1983. There is also general agreement in the United States that short-term tests, such as the Ames test, etc., are not meaningful when fungicides, including captan, are being tested. These tests are not meaningful for the following two reasons: the short-term tests usually involve bacteria, fungi or moulds which materials such as captan are specifically designed to kill or alter; and these tests are usually single cell tests which remove all natural protection mechanisms from the cells.

2) INDUSTRIAL BIOTEST LABORATORIES (I.B.T.)

Captan is one of the pesticide products included on the I.B.T. list from Health and Welfare Canada. Compounds on the list have been placed into one of four categories according to the extent and importance of the I.B.T. invalid study. While captan is on the list, neither Health and Welfare Canada nor Agriculture Canada has ever placed captan in one of the four categories. It has always remained outside of the I.B.T. review. On December 29, 1981 The Honourable Eugene Whelan, the federal Minister of Agriculture announced that all pesticide products containing captan would carry precautionary labelling by March 1, 1982. The precautionary labelling would specify that "Safety data and registration of this product are under review. Directions for use and cautionary statements should be carefully followed. Read the label before using".

I. ENVIRONMENTAL IMPACT

1) GENERAL

Captan is a multi-use compound which plays an important role in agriculture, domestic and industrial endeavours. No single fungicide is available to replace captan at this time. Captan contributes to our available food supply, our economy and to the aesthetic value of food, as well as to the satisfaction of growers. It also assists in reducing the problems of resistance, which are beginning to appear with certain other fungicides. No resistance to captan has appeared to date.

2) NATURAL ENVIRONMENT

An examination of the scientific review and assessment of the impact of captan on the natural environment leads to the following conclusions:

i) All the scientific reports indicate that captan has no long-term deleterious effects on soil organisms or their activity.

ii) There is no evidence of bioaccumulation of captan in the environment.

iii) There is sufficient evidence to show that captan is rapidly broken down in all types of water and it also degrades rapidly in soils.

iv) There is no evidence that captan causes harmful effects to wild birds or mammals.

v) Captan has no adverse effects on micro-organisms in the aquatic environment and is not detrimental to the survival of crab eggs or crab zoeae.

vi) Captan residues on food commodities are surficial, and are substantially removed or degraded by natural rainfall.

vii) The residues of captan on fruit crops grown in Ontario have been found to be well below the tolerance levels established by Health and Welfare Canada, and no residues have been found on grains and vegetables.

3) ENVIRONMENTAL HEALTH

(i) General Toxicology of Captan

Acute Oral Toxicity

L.D.$_{50}$ $>$ 15,000 mg/kg mice
L.D.$_{50}$ 9,000 mg/kg rats
L.D.$_{50}$ 1,800 mg/kg rabbits

Acute Inhalation

L.C.$_{50}$ 5.7 mg/L rates in continuous flow of captan dust (Sherman rate)

L.C.$_{50}$ 4.5 mg/L (Swiss-Webster mice)

Dermal Toxicity

Captan does not exhibit dermal toxicity. It may cause skin sensitivity reaction, i.e., act as a skin irritant - 900 mg/kg is reported to cause slight skin irritation. No problem has been reported from normal application.

Lethal Concentration

5 day diet L.C.$_{50}$ $>$ 5000 ppm mallards and pheasants

L.C.$_{50}$ 2000 - 6000 ppm bobwhites

Levels which caused no acute or chronic toxicological effect in:

Rats	1070 mg/kg/day
Mice	1000 mg/kg/day
Dogs	100 mg/kg/day

(FAO Supplement #15, 1978)

On the basis of the toxicity data available, a TLV of 5 mg/m^3 and a STEL of 15 mg/m^3 are recommended by the American Conference of Governmental Industrial Hygienists (ACGIH, 1981).

TLV: Threshold Limit Value
STEL: Short Term Exposure Limit

ii) Environmental Health Review by the Ontario Pesticides Advisory Committee

An examination of the scientific review and assessment of the impact of captan on the environmental health leads to the following conclusions:

1. Many short-term mutagenic tests carried out using bacteria (Ames tests), moulds, fungi, Drosophila and in vitro vertebrate cells show captan to be mutagenic. This fact initiated a concern and resulted in a statement by E.P.A. that captan may be mutagenic to human beings.

2. The report that captan, when fed in high dosages (8,000 and 16,000 ppm) to mice, caused increased duodenal tumors raised fears that captan may be oncogenic in humans. The fact that captan fed at high levels (6,000, 8,000 and 16,000 ppm) to mice will result in increased duodenal tumors has been confirmed.

3. All studies to date indicate that the high levels of captan which cause an increase in duodenal tumors in mice do not result in similar phenomena in the rat. The mouse in this case may not be the best test species for chronic toxicological studies because of possible physiological over-burdening of the system and its particular susceptibility to tumor formation.

4. The lack of carcinogenicity in the chronic feeding studies using captan, other than in mice, may have occurred because the captan was destroyed, either by the sulfhydryl groups in the diets and the stomach, or by the blood itself.

5. While a single study indicated that mice fed captan showed liver tumors, the authors concluded that captan was not the causal agent. Other studies have reported a significant decrease in liver tumors in mice as the dose rate increased.

6. Captan is rapidly metabolized. Based on a possible metabolic pattern, thiophosgene is a likely intermediate. Thiophosgene may act as an alkylating agent capable of reacting with DNA. There is, however, evidence that captan is detoxified in humans and other animals in the gastrointestinal tract, and that neither captan nor its metabolites persist in the body. The animal metabolites of captan have been negative in mutagenic tests.

7. The Stauffer Chemical Company reports that an epidemiological study carried out on workers exposed in the manufacture of captan from 1954 to 1976 indicated no increase in cancer in the workers when compared to the national, state or local cancer mortality rates.

8. There is no evidence to date that captan has caused any increase in chromosomal aberrations in test animals.

9. To date, no evidence is available to show that captan has caused an increase in the rate of embryonic deaths in test animals.

10. While in vitro studies dealing with the possible mutagenicity of captan indicated that captan showed a very high convertogenic activity and severe mitotic inhibition, the in vivo cytogenetic animal studies showed no chromosomal aberrations or mitotic inhibitions.

11. No teratogenic effects have been produced by captan in female mice or other vertebrates during the gestation period by inhalation, oral, or subcutaneous administration.

12. No fetoxtoxic effects have been shown by vertebrates when exposed to captan.

13. The residues of captan on fruit crops grown in Ontario have been found to be very low, and these surficial residues are reduced substantially by rainfall, and are virtually eliminated by washing the produce, or cooking. No residues of captan have been found on grains and vegetables. This means human dietary exposure is minimal.

14. The "Rationale for the Recommendations of March 31, 1981 on Status of Captan", issued by the Health and Welfare Canada, contains some vague statements, and does not take into consideration all of the new 1980 or 1981 data available. The only 1981 data quoted is from a preliminary report of a long-term feeding study which will not be completed until late 1982. Any firm conclusions from this study must await the final report.

15. EPA and WHO have both increased tolerances for captan on certain food commodities. EPA has indicated that they are not planning to take any action against captan under RPAR at this time. They also do not anticipate that the current studies underway will bring forth any new information.

16. There is no scientific evidence available in the review, as carried out, to indicate that an undue human risk is involved by the continued use of captan.

17. Increased label precautions are suggested for domestic uses. For domestic application, the use of a nose and mouth filter is important. Individuals who formulate, handle, or apply pesticides including captan should take steps to minimize exposure to all possible routes of entry of pesticides.

(iii) Food & Feed Commodity Residue Tolerances

The following tolerances have been established by Health and Welfare Canada for captan:

TOLERANCE PPM	COMMODITY
40	apricots, celery, cherries, grapes, leeks, lettuce, mangoes, onions, peaches, plums, shallots, spinach.
25	apples, avocados, beans, blackberries, blueberries, citrus fruits, crabapples, cranberries, cucumbers, dewberries, eggplants, garlic, loganberries, melons, pears, peppers, pimentos, pineapple, potatoes, pumpkins, quinces, raspberries, rhubarb, strawberries, squash, tomatoes.

2	almonds, beets, broccoli, Brussels sprouts, cabbages, carrots, cauliflower, collards, kale, mustard greens, peas, rutabagas, soybeans, sweet corn, turnips.

(iv) Recommendations of Health and Welfare Canada on Captan to Agriculture Canada, March 31, 1981

On March 31st, 1981, Health and Welfare Canada made the following three recommendations to Agriculture Canada on Captan:

(1) All registrations of captan containing products sold for use in or around a dwelling be discontinued.

(2) All registration of products containing captan for use on foods or food crops require that foods sold at the retail level be free of captan residues as determined by the official method.

(3) Provinces be asked to regulate and educate applicators of captan.

(v) ONTARIO PESTICIDES ADVISORY COMMITTEE'S RESPONSE TO THE RECOMMENDATIONS FROM HEALTH WELFARE CANADA ON CAPTAN RESPONSE TO AGRICULTURE CANADA .

RECOMMENDATION #1 & #2

The review and assessment of the available scientific data on captan by the Ontario Pesticides Advisory Committee, from the point of view of its impact on the natural environment, environmental health and potential residue remaining on food commodities would not support the first two recommendations of Health & Welfare Canada. The amount of captan used in the domestic market is minimal (approximately 5%). Its removal, combined with the fact that there is to-date no scientific evidence to restrict captan, would place an undue hardship on the general public. As there is no suitable substitute at this time, many fruit producers and home gardeners would be denied the self-satisfaction and pride that accompanies the production of unblemished produce.

Similarly, to place our agriculture sector at a disadvantage by removing the food commodity tolerances for captan while allowing produce from the United States and other exporting countries to enter Canada with residues of captan is not justifiable without sound scientific evidence. This evidence is not available at this time. Unnecessary exposure to any pesticide is extremely important. The Ontario Pesticides Advisory Committee would support increased label precautions for domestic uses. For domestic applications, the use of a nose and mouth dust filter is sensible and this recommendation should appear on the label of domestic products.

RECOMMENDATION #3

The Province of Ontario through the Pesticides Act and Regulations, has implemented a sound regulatory program for pesticides. The educational aspects of the Ontario program are extremely important.

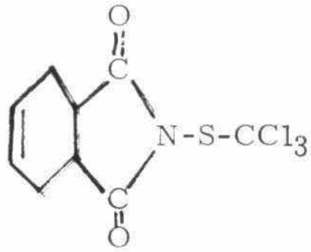
Health and Welfare Canada are vague in their definition of applicator; and if they include the general public, agriculturists and commercial applicators, then the regulatory and educational programs are monumental. The present system would allow the Pesticides Control Section to inform all licenced applicators and vendors of the current status of captan. As well, through systems already in place, the pesticide industry's and the Ontario Ministry of Agriculture and Food's educational material could be disseminated to agriculturists. However, considering that there are 24 million people in Canada, that there are 8.5 million people in Ontario and approximately 86,000 farmers in Ontario, a regulatory program would not be practicable. No province could effectively mount a program to administer a licencing and/or permit system for each and every use of captan. It would appear that Health and Welfare Canada are recommending certification of all applicators of captan. Based on our review and assessment this is not justifiable since there is no available scientific data at this time upon which to base this decision. If Health and Welfare Canada do determine that captan poses a danger, then they have the mechanism to take action through the removal of tolerances on food and feed commodities for captan. Further, Agriculture Canada has required that all products containing captan carry precautionary labelling by March 1st, 1982. The precautionary labelling would specify that "Safety data and registration of this product are under review. Directions for use and cautionary statements should be carefully followed. Read the label before using."

CAPTAN

Chemical Name: - cis-N [(Trichloromethy)thio] -4 cyclohedene - 1, 2 - dicarboximide.

Generic Name: - captan

Chemical Structure: -



Empirical Formula: - $C_9H_8O_2NS\,cl_3$

Other Names: - Orthocide

Melting Point: - Pure captan 175° c Technical 164° c

Physical State: - White solid

Color: - Pure captan is white - Technical grade yellow to gray

Odor: - Pure almost odorless. Technical has odor of perchloro (methylmercaptan) and thiophosgene

Solubility: - Almost insoluble in water. Low solubility in organic solvents

Stability: - Quickly broken down in alkaline media
Rapidly hydrolyzed in water.

Formulations: - Wettable powder, dust, special seed treatment formulations - mixed with: - diazinon and lindane; maneb; and with methoxychlor.

Toxicity: - Acute oral (rat) LD_{50} 9000 mg/kg
Acute dermal (rabbit) >7,500 mg/kg
(Applied 4 times a week for 24 weeks)
May cause skin irritation to humans and irritate nose and eye.
Acute oral (mouse) LD_{50} ->15 g/kg (Waters, M.D. *et al*

CAPTAN

CURRENT RE-EVALUATION OF CAPTAN

FEBRUARY, 1982

INTRODUCTION:

Many studies carried out subsequent to the introduction of captan in 1951 indicate that captan should not have adverse effects on water, fish, soil, soil microorganisms, birds or other forms of wildlife. It was found that captan does not bio-accumulate in the natural environment. Captan is rapidly hydrolyzed by water and disappears quickly in soil. There are no reports of adverse effects to the natural environment by the fungicide captan.

In the area of environmental health, a chronic feeding study, utilizing both rats and mice, was initiated by the National Cancer Institute, and the report issued in 1977 indicated that the mice receiving 16,000 ppm of captan in their daily food developed duodenal adenocarcinomas (tumors). These were not found in the rats receiving the same levels of captan. It was also reported that there was a decrease in the incidence of hematomas and lung tumors in the treated animals of both species. The positive results in mice at the 16,000 ppm level, along with the numerous positive reports obtained using the short-term battery of tests for mutagenicity, raised the question of the acceptability of captan's use in the area of environmental health. A great deal of scientific data has been reviewed including all available work in 1979, 1980 and 1981, and the following report reflects the findings.

NATURAL ENVIRONMENT

Captan - Soil:

Konde, B.K., et al., reported that seed treated with captan stimulated the nitrogen-fixing and the growth of Azobacter. No harmful effects were found.

Leger, R.G., et al., treated muck soil with aqueous solutions of captan containing 700, 1,400 and 2.800 ppm of 50% W.P. The muck soil contained two earthworm species, Lumbricus terristris and Allolobophora turgida. After 42 days, 95% of the L. terristris remained, as did 100% of the A. turgida. Analysis of the earthworms that were exposed to the treated muck soil gave no indications of captan or its metabolites being present. It was concluded captan in soil did not harm earthworms even at the high levels used in the test.

Kuthubutheen, A.J., et al., reported that sandy loam soils were sprayed at 28 day intervals for one year with captan at the rate of 9 kg/ha. The captan reduced the target and non-target fungal population 23% at the end of the twelve month test. The captan-treated plots were recolonized within seven days of the last application.

Captan Decomposition: Plants -- Water -- Soil

Gile, J.D., et al., in 1979 reported that captan degraded rapidly in soil and plants. After 45 days total soil residues (parent + metabolites + bound residues) declined from the 3 ppm level at beginning to 0.26 ppm level. There were no detectable residues of the parent compound. Residues in invertebrates and voles (soil inhabitants) were found to be very low. There was no effect on vole population or survival.

Mabey, W., _et al._, reported in 1978 that the hydrolysis of captan in water under environmental conditions was the same as that found for distilled water. No delay in speed of hydrolysis was found.

Paris, D. F., _et al._, stated that in their study of microbial degredation and accumulation of pesticides in aquatic systems, captan underwent neither microbial depredation or sorption because of its rapid hydrolysis in water.

Ferris, R.S., _et al._, found little effect on the population dynamics of soil microorganisms when captan treated seed pieces of caladium corms were seeded. Bacteria increased on the caladium pieces both on the check and treated pieces while the fungi population dropped on and close to the treated pieces for a short period but returned to normal after several days.

Frank, R. reported that residues of captan found on Ontario peaches, apples, strawberries, cherries and grapes, when found, were always well below the tolerances established by the Federal Department of Health and Welfare. He also reported that as high as 94% of the residue could be removed by washing the produce before analyzing. No residues of captan were found on vegetables in 1980 or 1981 samplings.

CAPTAN RESIDUES IN FRUIT AND VEGETABLES
IN ONTARIO

1. Monitoring Fruit & Vegetables. No residues of captan have been found in the following vegetables tested this far: asparagus, cabbage, cauliflower, cucumbers, peppers, potatoes, sweet corn and tomatoes. Residues have been found in the following crops.

Fruit	Year	Total No.	Captan <0.1	0.1-1.0	1.0+	Mean	Maximum
			← no. samples		→	← ug/g	→
Peaches	1980	7	4	3	0	0.29	0.88
	1981	7	0	2	5	2.83	9.00
Apples	1980						
- McIntosh		27	19	8	0	0.14	1.00
- Red Delicious		21	18	3	0	0.07	0.44
- Northern Spy		3	3	0	0	< 0.01	0.01
Strawberries	1980	5	1	3	0	0.32	0.76
	1981	14	3	5	6	0.87	2.40
Sweet Cherries	1980	5	1	3	1	0.58	1.70
	1981	5	1	1	3	1.92	4.90

2. Removal of Captan. The following are the findings as a result of washing fruit.

Crops	Number	Captan (ug/g) Unwashed	Washed	Removal (%)
Peaches	6	3.53	1.14	68
Sweet Cherries	5	1.92	0.11	94
Strawberries	1	0.89	0.20	78

3. Disappearance of Captan. Sour cherries, peaches and French hybrid grapes were sprayed with 3.4 kg/ha of captan. Declines in captan residues were correlated to rainfall. The rapid declines in residues on sour cherries occurred (a) during an 81 mm rain between Day 3 and 6, and (b) a second rain (42 mm) between Day 9 and 12. The rapid decline in peaches between Day 0 and Day 1 was following a 27 mm rain. Losses from grapes appeared to be less affected by rain.

Crops	Period	Captan (ug/g) Initial	Day 1	Day 3 or 4	Day 9 or 10	Day 14 or 15
Sour Cherries	Mid-Late July	5.3	6.0	5.2	0.3	0.1
Peaches	Late July - Early Aug.	9.9	7.3	2.7	2.2	1.7
Peaches	Mid August	12.1	6.5	5.8	4.8	-
Grapes	Late Aug. - Sept.	8.3	7.3	4.9	4.1	3.8
Grapes	Sept.	3.3	4.5	3.1	4.6	3.5

Prepared by: R. Frank, Ph.D.

Provincial Pesticide Residue Testing
Laboratory
Ont. Ministry of Agriculture & Food

Captan - Wildlife:

Birds:

The LC_{50} for birds fed for five days with feed containing captan were:

LC_{50}	Mallard duck	$>$5000 ppm
	Bobwhite quail	2000 - 6000 ppm
	Coturnix quail	$>$5000 ppm

Work done by Pimentel, D., Cornell University, and referenced by McEwen F. and Stephenson, G.

Bennett, R.S., Michigan State University offered feed treated with captan at various rates to ring-necked pheasants. All feed including untreated checks were offered as free choice and all were available at the same time. The untreated feed was consumed first, and this was followed by the feed with the least amount of captan on it. All treatments were consumed, and no ill effects to the pheasants were reported during or after the feeding trial.

Stromborg, K.L. working on a Ph.D. thesis at Michigan State University explored the sublethal effects of captan-treated seeds on laying pheasants (Phasianus colchicus). He recorded a slight decrease in food consumption initially, but there were no effects on hatchability or chick survival. Birds receiving 7 days treatment did not differ from those receiving 14 days treatment as far as egg laying, etc. were concerned. Pheasants gathered from the fields showed that 45% of the birds sampled had consumed seed corn treated with captan and other pesticides. From his work feeding diazinon treated seed and diazinon plus captan treated seed he reported that such seed treatments represented a potential hazard to the reproductive performances of female pheasants if the amount of treated seed makes up 6 to 12 % of the daily intake. Captan used alone as a seed treatment did not show any such adverse effects.

MAMMALS

Kennedy, G. L., et al., reported that pregnant beagle bitches fed throughout the gestation period on diets containing 0, 30 and 60 mg/kg of captan showed no signs of toxicity, gained weight normally, and all had the normal number of live pups. All pups were normal, and after being sacrificed after weaning (8 weeks) showed no abnormal toxicological findings. The bitches, which were also sacrificed after the pups were weaned, showed no adverse toxicological findings. It was concluded that neither the survival or growth rate of the pups was affected at any of the dose levels fed to the bitches either pre- or post-natally. At levels fed in this experiment the dogs were not adversely affected by the exposure to captan.

Giles, J. D., et al., reported that the gray-tailed vole (Microtus canicaudus) was not adversely affected by captan seed protectant coatings. Analysis showed there was no ecological magnification of captan in the soil or in the vole.

Aquatic Life

Toxicity of Captan to the Dungeness Crab. 1978

Caldwell, R.S., *et al.*, reported that captan did not affect the survival of Dungeness crab zoeae exposed to 30 µg/litre^{-1} during 69 day chronic toxicity test. The larvae were quickly killed at 450 µg/1^{-1}. Delayed moulting did occur at 30 µg/1^{-1}. No deaths to adult crabs exposed for 75 days at 340 µg/1^{-1}. Captan appeared to accelerate the hatching of eggs at concentrations of 100 to 10,000 µg/1^{-1}. At the 3,300 and 10,000 µg/1^{-1} concentrations the developing zoeae exhibited some morphological deformity. Under the conditions of the test, the half-life of captan appeared to be from 23 to 54 hours. After testing was completed, it was concluded that captan, because of its relatively low toxicity and its high rate of degradation in sea waters will not pose a hazard to the natural crab populations or crabs in laboratory culture. Furthermore, the prophylactic use of captan as a fungicidal treatment for Lagenidium sp. (a fungus) in larval crab cultures is safe when used at the recommended dosages.

ENVIRONMENTAL HEALTH

Introduction

The RPAR against captan was issued in August, 1980 by EPA. A review of the RPAR deposition reveals that the deposition was initiated because of some major concerns held by the EPA at that time. These concerns were in the fields of possible mutagenicity and oncogenicity. The fear that captan may be a mutagen arose from the many positive short-term tests which utilized unicellular organisms (Ames tests), molds, fungi, drosphila and in vitro vertebrate cells for testing. The oncogenic concern arose from a report from NCI that indicated tumor formation in the duodenum of mice fed very high levels of captan in their daily diet. This has been confirmed by additional testing, but only at very high levels. These rates did not produce tumors in rats or other test animals.

Positive short-term tests which had been reported from time to time to WHO by various research workers led to the establishing of new tolerance limits for captan in 1974. A review of new data was made by the toxicologists in 1977, and in 1978. The same residue limits were again issued by WHO, indicating that after reviewing the new data no changes were indicated by the results of the studies.(18) In 1980, after another review, WHO recommended that, based on new data, the maximum residue level for captan on cherries and potatoes be increased so as to cover both pre- and post-harvest uses of the product.(19) The EPA, in October, 1981, also established new tolerances for captan and its metabolites in fat, meat, and meat by-products of pork and beef.(17)

A recent telephone conversation with EPA (Mr. Rolleffs), indicated that there was no longer the great concern regarding captan that existed in 1980. It was learned that, upon the advice of their Scientific Advisory Panel, any decision and conclusive action await the completion of two long-term studies currently under way. It is expected these tests will be completed in 1982. There is also general agreement in the U.S. that short-term tests, such as the Ames test, etc. are not meaningful when fungicides, such as captan, are being tested.

Review:

The RPAR against captan was issued August 18, 1980 by EPA. A review of the RPAR deposition reveals that the deposition was initiated because of some major concerns held by the EPA at that time. Just prior to this, it was also noted that some of the data supplied for captan registrations came from the IBT Labs. The major concerns were in the areas of possible mutagenicity and oncogenicity. The fear that captan may be a mutagen arose from the many positive short-term tests which utilized unicellular organisms (Ames tests), molds, fungi and *in vitro* vertebrate cells for testing. The oncogenic concern arose mainly from a report from the National Cancer Institute that indicated that tumors were found in the duodenum of mice fed very high levels of captan for two years. These did not occur in the rat study. The duodenal tumor formation in mice fed high levels of captan (16,000 ppm) in their daily diet has been confirmed by a later interim report covering a new test. No tumors have been reported in the rat or other test animals. The following report outlines the data reviewed which includes all of the 1979, 1980 and 1981 toxicological data available dealing with captan.

Oncogenicity:

(1) NCI Mouse Studies, 1977
(2) Chevron 2-year Mouse Study
(3) Mouse Study, 1969 (Innes, *et. al.*)
(4) Stauffer/Chevron Mouse Study
(5) NCI Rat Study, 1977
(6) IRDC Rat Study, 1980
(7) Human Studies

(1) NCI Mouse Study, 1977

Massive dose levels of 8,000 and 16,000 ppm of captan were fed to mice. The treatment group consisted of fifty males and fifty females, with ten matched controls per sex. A dose-related increase in the incidence of tumors of the small intestines was seen in males and females:

Control	0/20
8,000 ppm	1/92
16,000 ppm	6/94

The researchers considered the incidence of duodenal adenocarcinoma statistically significant at the 16,000 ppm level, but not at the 8,000 ppm level. At the same time, the researchers reported decreased incidences of hepatomas and lung tumors in the treated animals in this study.

(2) Stauffer/Chevron two-year mouse study

Preliminary report confirms increased incidence of tumors of the upper small intestine among captan-treated mice fed massive doses of 6,000, 10,000 and 16,000 ppm.

In both studies (1) and (2) the limiting factors that are found are:

(a) Massive doses of captan were fed, up to 1.6% of the diet of the treated test animals. The test animals maintained normal growth curves.

(b) The tumor found by the investigators was site specific. There was no evidence in either study of a statistical increase in tumors in other tissues or organs examined.

(3) Innes, J.R.M. et al. - "Bioassay of pesticides and industrial chemicals for tumorigenicity in mice", 1969

The researchers report that captan did not cause a significant increase in tumors in mice. The number of test animals was small, it was continued for only 18 months, and only one dose level was used. There are many other deficiencies in the design and the conduct of the study, all of which render the study scientifically invalid.

(4) Stauffer/Chevron Mouse Study by Bio/Dynamics

Test by Stauffer/Chevron chemical companies to determine a dose-response relationship at a lower and more realistic dose level. Dosage rates of 100, 400, 800 and 6,000 ppm are being fed to mice. These studies are not yet completed. Results are expected in early 1982.

(5) NCI Rat Study, 1977

A statistical analysis of the data from the NCI rat study clearly shows no increased incidence of any type of tumors. There were no tumors of the duodenum in the rats, as were found in mice. The NCI investigators, in their conclusions, reported that "no lesions were seen which could be attributed to captan".

(6) IRDC Two Year Rat Study, 1980

List completed October 1980. The 18-month interim sacrifice showed no adrenal or thyroid tumors, or duodenal tumors at any dose level (250, 100 and 25 mg/kg/ day captan in the diet). It would appear that captan is not carcinogenic in rats.

(7) Human Studies: Epidemiology Study - Stauffer REPORT

Study of workers involved with captan between 1954 and 1976 permitted observations of health effects related to long term exposure to captan. The results of the study showed no excess cancer in the employees when compared with the national, state, and local cancer mortality rates. No cases of cancer of the duodenum or upper small intestines were found. These studies may not be considered very strong.

The EPA National Human Monitoring Program has detected no residue of captan in human blood serum or adipose tissue.

Mutagenicity:

Short Term Studies:

Several short-term *in vitro* studies show that captan causes base pair substitution in cultured systems of bacteria, (Positive Ames Tests) eukaryotic microorganisms and mammalian cells. No risk to man can be extrapolated from such systems, due to their high susceptability and the lack of repair mechanisms which are present in the higher animal forms.

Long Term Studies (Chronic):

The EPA bases its RPAR on mutagenicity on the following long-term feeding studies:

(a) The NCI study which tested both rats and mice
(b) The Innes study which tested mice
(c) The preliminary report of the Stauffer/Chevron study using mice
(d) The Hazelton Laboratories rat study
(e) The two IBT studies - one on mice, and one on rats -

As the two IBT studies were declared invalid by EPA, and the Hazelton study was judged to be inconclusive because of the small sample size and short-term high dose testing, the issuing of the RPAR is based on the NCI and Innes Study only. Reference is made to the Stauffer/Chevron study.

(a) The NCI rat study at Gulf South used 50 animals per sex, per dose, and ten matched controls per sex. The original treatment of 8,000 ppm and 16,000 ppm proved to be too toxic, so the dosage was lowered to 2,525 ppm and 6,050 ppm in the diet for 80 weeks. Treatment stopped, and rats were observed for an additional 33 weeks. Investigation found no statistical increase in tumors. There did appear to be dose-related trends for adrenal cortical tumors in female rats and in C-cell adenoma of the thyroid in female rats. In order to find the dose-related trend in adrenal cortical tumors, the statisticians added adrenal cortical adenomas and adrenal cortical carcinomas. The authors of the report stated that there was no convincing evidence that the tumors observed in rats were related to treatment.

When the incidence of cortical adenoma and cortical carcinoma of the adrenal gland in female rats are combined, the Cochran-Armitage test for positive linear dose-related trend has a probability of 0.047, using pooled controls. The Fisher exact test results are not significant.

The incidence of C-cell adenoma in the thyroid also has a positive linear trend (P= 0.035), but the results of the Fisher exact test are not significant. No other tumor or combination of tumors appears in significantly larger numbers in the treated groups than in either control group.

Dr. William W. Carlton, D.V.M., Ph.D., Department of Veterinary Pathology, School of Veterinary Medicine, Purdue University, confirmed the conclusions of the NCI investigators, stating that both the biologic and statistical evaluations of the tumor incidence data established that these neoplasms (thyroid and adrenal glands) were of spontaneous occurrence and unrelated to captan administration.

(b) The Innes Study - see (3) under Oncogenicity.

(c) Stauffer/Chevron Mouse Study - 18 Month Preliminary Report - April 11, 1980

Study took place at Chevron's Environmental Health Centre. Study to be carried out until all test mice have been sacrificed. Dosage levels of captan to be 6,000, 10,000 or 16,000 ppm in the diet.

Results of animals sacrificed at 18 months confirmed the NCI mouse study. Epitheliel cell tumors were found in the upper portion of the small intestine of CD-1 mice fed at these high levels.

	Captan (ppm) in Diet			
	Control	6,000	10,000	16,000
Male	2/74	20/73	21/74	39/76
Female	2/73	24/78	19/76	29/76

The male incidence was somewhat higher than the female incidence. There was noted a reduction in the incidence of liver tumors in high dose of 2%, while in females it was also 2%. In the NCI study there was a reduction of 33% for males and 10% for females. The data also showed a reduction in lung cancer and overall tumor incidence. The final histopathological tumor and lung cancer data will be included in the final report once the study has been completed.

Additional Mutagenic Studies

Shirasu, Y., *et al.*, reported in 1978 that there was no significant increase in the number of structural and numerical aberrations of chromosomes of the human diploid fibroblast cells *in vitro* treated with captan at concentrations of 0.5, 1.5, 3.0, and 4.0 ug/ml for four or twenty-four hours. There was, however, an increase in stickiness and a decrease of mitotic index in the treated cells. Cytogenic effects *in vivo* were also studied on the metaphase chromosomes of bone-marrow cells of male rats, four weeks old, treated by a single intubation with 0, 500, 1000 and 2000 mg/kg, or by consecutive five-day administrations with 0, 200, 400 and 800 mg/kg. Sacrifice took place 24 hours after last injection. There was no increase of chromosomal aberrations in the bone-marrow cells of the treated animals at all the dosage levels.

Dominant-lethal studies were performed in mice. Ten week old male mice (C3H) were treated orally with captan at 0, 200 and 600 mg/kg/day for five consecutive days. Males were mated with untreated virgin females. Captan induced no significant increase in the rate of embryonic deaths. (Abstract 79-0430).

De Bertoldi, M., et al. studying the mutagenicity of pesticides evaluated by means of gene conversion in S. cerevisiae and A. nidulans reported that captan showed a very high convertogenic activity, approximately five times more than MMS (the standard mutagen trend). (Abstract 78-1674).

Tezuka, H., et al. carrying out cytogenic and dominant lethal studies with captan reported that in vitro cytogenic studies with cultured human diploid cells there was a significant increase in the frequency of cells showing stickiness and a severe mitotic inhibition at concentrations of 3.0 and 4.0 ug/ml of captan although no chromosomal aberrations were observed. In in vivo cytogenic studies no chromosomal aberrations were observed in the bone marrow cells of rats treated orally with captan at a single dose of 500, 1000 or 2000 mg/kg or at five consecutive doses of 200, 400 or 800 mg/kg/day. Dominant lethal studies also failed to show any mutation induction after treatment of male mice with daily oral doses of 200 or 600 mg/kg of captan for five consecutive days.

Moriya, M., et al. in studying the effects of cysteine and a liver metabolic activation system on the activities of mutagenic pesticides reported included captan in their study. Compounds containing the sulfhydryl group, e.g., cysteine, and of a drug-metabolizing enzyme system, e.g., rat-liver homogenate, and blood, rapidly and readily inactivated captan. It was also suggested that these characteristics be taken into consideration in any explanation of the lack of carcinogenicity in the chronic feeding studies carried out with captan. Two possible explanations are offered for the negative results in the long term studies:

(a) a considerable amount of the captan may be destroyed in the diets by the sulfhydryl groups contained in the diet or much more likely in the stomach, or

(b) even if the captan is absorbed from the gastrointestinal tract it is rapidly destroyed by the blood.

Captan is very unstable in vivo.

Simon, V.F., et al., in the evaluation of selected pesticides and chemical mutagens, both in vivo and in vitro, reported that none of the compounds tested in in vivo produced a dominant lethal response in mice, but captan was mutagenic in all of the in vitro assays.

Teratogenicity

Courtney, K. D., et al., carrying out inhalation teratology studies with captan reported that female mice exposed to 488 mg/hr m^3 for four hours a day from the six through the 15 day of gestation showed no malformations in any of the fetuses. Captan was also administered orally and subcutaneously at 100 mg/kg/ day from the six through 15 day of gestation. While there was a slight increase in fetal mortality demonstrating some toxicity there were no malformations produced by captan using oral, subcutaneous, or inhalation routes of exposure.

Effect of Captan on Human Lymphocytes in vitro

The effects of captan on sister-chromatid exchanges were studied by Vigfusson and Vyse. Captan has been shown to produce point mutations in bacteria and in Chinese hamster cells and indications are that it may increase the frequency of chromosomal aberrations in vitro. Other data on the mutagenicity of captan shows conflicting results in mammalian systems and in drosphila.

The sister-chromatid exchange (SCE) frequency in mammalian cells is a sensitive method of measuring the potential mutagenicity of chemicals. The SCE's have been found to increase with increasing concentrations of mutagens and carcinogens. Captan, at the lowest concentration, (10^{-5}M) significantly increased the SCE levels over controls, but at any higher concentration the growth of human lymphocytes was inhibited. The data from the captan portion of this test is very limited and incomplete, but it does show the SCE's are significantly higher when cells (in vitro) are exposed to captan than when exposed to ethylmethane sulfonate.

This work was done on cultured human lymphocytes using McCoy's 5A medium. The captan was dissolved in 7% ethanol followed by a dilution of 1:4 dilution in water. No studies were done using the solution alone.

Biochemical Reactions

Metabolism

The investigation of the metabolism of captan is an essential component of the oncogenic risk. Captan is rapidly metabolized and that, based on the metabolic pattern of captan, thiophosgene is a likely intermediate. Thiophosgene may act as an alkylating agent capable of reacting with DNA. It is suggested that thiophosgene may be responsible for initiating induction of tumors of the upper small intestine in mice. Metabolic studies also show that captan is detoxified in the gastrointestinal tract. There is also evidence that captan and its metabolites do not persist in the body.

Captan is decomposed in vitro by thiols and sulfite and thiosulfate ions with scission of the nitrogen-sulfur bond. Reaction with cysteine in vitro yields tetrahydrophthal imide (THPI) and thiophosgene, which eventually condenses with another cysteine molecule to form thiazolidine-2-thione-4carboxylic acid (TTC). (Lukens, R. J. and Sisler, H. D., 1958. Science). Although captan has been shown to react with cellular nucleophiles other than thiols (Lukens, R. J., and Sisler, H. D., 1958 - Phytopathology, and Siegal, M. R., 1971 - Pest. Biochemistry and Physiology), it is approximately a million times more specific for thiols than for amino groups (Burchfield, H. P., and Storre, E. E., 1969 - "Fungicides and Advanced Treatise", Academic Press, pp. 61-100).

The fate of THPI portion of the molecule has been determined in the rat and goat using radioactive captan. It is rapidly metabolized and excreted by both species. Forty-eight hours after receiving a single oral dose (app. 80 mg/kg), rats excreted 92% of the administered radioactivity. The average total recovery of the administered radiocarbon 96 hours after treatment was 97%. Some 85% was excreted in the urine and 12% in the feces. No radiocarbon was found in the expired CO_2 and tissues accounted for only 0.1% of the ^{14}C dose.

In the case of goats, 95% of the ^{14}C was excreted within 48 hours from the last dose from two animals that were tested at 20 or 100 ppm in the diet for three consecutive days. The excreted ^{14}C was equally divided between urine and feces. The milk contained 0.1% to 0.2% of the dose at sacrifice, six (20 ppm) and seven (100 ppm) days after the final dose, organs contained

0.01% or less of the ^{14}C dose. Muscle contained less than 0.2%, and fat contained nil. Ninety-five to ninety-eight per cent of the radioactivity in the muscle, liver and kidney was water soluble indicating that degradation products accounted for virtually all of the tissue ^{14}C.

Based on the distribution of metabolites found in the urine, biotransformation pathways of ^{14}C captan are similar in the rat and goat. Cleavage of the nitrogen-sulfur band gives rise to THPI (15% for rat, 0.7% for goat). Ring-hydroxylation of THPI yields 3-hydroxy-THPI (38.4% rat, 4.6% goat) and 5-hydroxy-THPI (10.1% rat, 0.7% goat). Two of these "imides" are further (Hoffman, DeBaun, Knair and Menn - Stauffer Chemical Co. 1973) hydrolyzed to give their respective "amic acid" derivatives: tetrahydrophthalamic acid (THPAM: 11.7% rat, 8.1% goat) and 3-hydroxy-THPAM (7.1% rat, 35.1% goat). In addition to hydroxylation, THPI is also oxidized to give 4,5-epoxy-THPI (5.2% rat, 1.9% goat) which, in the case of the rat, is further hydrolyzed to 4,5-dihydroxy-THPI (10.9%). All of the unidentified urinary radiocarbon from the goat was water soluble, and no unchanged captan or captan-epoxide was detected in the urine of either species. THPI appears to be a true detoxification product as evidenced by the fact that THPI induced no mutations in an in vitro bacterial test system in which captan was mutagenic. (Seiler, J.P. 1973).

Studies which determine the disposition of the TMT group provide the most critical information regarding the ability of an organism to detoxify captan. This is due to the stable biological reactivity of the TMT moiety and the thiophosgene which is generated from it by the reaction of captan with thiols.

Studies suggest that the TMT-derived thiophosgene is effectively detoxified in the rat by (1) conversion to CO_2, (2) reaction with cysteine to yield TTC, and (3) reaction with sulfite to yield DTMS and its sulfoxide. Couch, et al. reported that rats treated with a single i.p. injection of $[^{35}S]$ captan at the rate of 6 mg/kg eliminated 60%, 11% and 5% to the total dose in the urine 24 hours, 28 hours and 72 hours after treatment, respectively. The elimination in the feces for the same period was 8%, 4%, and 1%. Elimination rates for rats treated with three i.p. injections (6 mg/kg) were essentially the same for the single dose, i.e. 90% excretion after 72 hours. The same authors also reported that although captan did exert a toxic effect *in vitro* on genetic material from rat liver, no such effect was observed *in vivo* under the conditions described above. In fact, even although i.p. injections brings the $[^{35}S]$ captan into direct contact with the liver, nuclei isolated from the 3-dosed rats contained only 0.008 - 0.009 ug ^{35}s/g tissue.

The reactions in the gastrointestinal tract of the rat play a major role in the metabolism of captan. Fifty per cent of an oral dose of 100 mg/kg of $[\text{TMT - }^{K/}\text{C}]$ captan was cleared from rats in nine hours, whereas only 50% was cleared only after two days of an i.p. dose of 20 mg/kg. It was also noted that after the i.p. dose the major metabolites in the urine DTMS and its sulfoxide were not found. The fact that the sulfite required to form these metabolites may be derived from dietary sources, from the oxidation of sulfur amino acids, or from the reduction of sulfate by the intestinal mucosa, may explain why the urine metabolites are missing in the i.p. treatment. The acute oral LD_{50} for the rat is 15,000 mg/kg, and the acute i.p. LD_{50} is 50-100 mg/kg. This tends to support the concept that the gastrointestinal tract is the primary site of detoxification after oral administration of captan to rats.

The gastrointestinal metabolism of captan in mice is very important, as is evident in the finding that the oral administration of captan resulted in an increase in free thiol groups in the duodenal tissue (Miaullis, J.B., Stauffer Chemical Co., 1978). In mice fed diets ranging from 500 ppm to 16,000 ppm captan, duodenal thiol increased from 140% to 220%. Maximum thiol levels were reached within three days of first exposure, and were maintained over the 200 day feeding trial. Liver thiols were not affected, except for a slight depression at the highest feeding level. The increase in free duodenal thiol is apparently a phenomenon which occurs in response to exposure to captan and/or thiophosgene.

The report of FAO/WHO in 1976 called "Pesticide Residues in Food" contains the following statement:

"More weight should be attached to the results of mutagenic tests in mammals than to those obtained from microbial or other non-mammalian systems or isolated cell systems. The significance of positive results from microbial tests, unsupported by information from tests of other kinds would be regarded as uninterpretable for purposes of establishing an ADI".

In 1978, the committee of the European Environmental Society which establishes the general principles and minimal criteria for mutagenicity testing stated:

"The indentification of a substance as a mutagenic agent in screening tests cannot provide information concerning the hazard to men. Detoxification of the mutagen in the body, its failure to reach the gonads, the activity of repair processes, and a variety of other factors may limit the ability of a mutagen to cause genetic alterations in man".

Captan Impurity:

Wilkes, P.S., from U.S. FDA Laboratory, Atlanta, reported that when analyzing fresh whole strawberries for captan bis-(trichloromethyl) disulfide using GC-MS analysis, a compound similar in structure to the trichloro methylthio moiety of captan was identified. This compound was found to be present as an impurity in the technical captan sample. (Abstract 80-0121 1980).

Breakdown - Soil

Gile, J.D. et al. in 1979 reported that captan degraded rapidly in soil and plants. After forty-five days total soil residues (parent + metabolites + bound residues) declined from the 3 ppm to 0.26 ppm. There were no detectable residues of the parent compound. Residues in invertebrates and the vole were very low. There was no adverse effect on the vole survival. (Abstract 80-0351 1980).

Mabey, W., et al., reported on the hydrolysis of captan under environmental conditions and found it to be the same as for distilled water. (Abstract 78-2545).

Kuthubutheen, A.J., et al., reported that sandy loam soils were sprayed at 28 day intervals for one year with captan at 9 kg/ha. The captan reduced the target and non-target fungal populations 23%. The captan-treated plots were recolonized within seven days of last application day. (Abstract 80-0712 1980).

Micro-organisms and Accumulation

Konde, B.K., et al., reported that seed treatment with captan stimulated the nitrogen-fixing and growth of Azotobacter.

Leger, R. G., et al., reported that aqueous solutions of captan at 700, 1400 and 2800 ppm 50% WP were used to treat muck which contained two earthworm species, Lumbricus terrestris and Allolobophora turgida. After 42 days 95% of the L. terristris survived as did 100% of the A. turgida. Analysis of exposed earthworms gave no indications of captan or metabolites. Concluded captan in soil not likely to harm earthworms.

Hanson, J.D., et al., reported that an average exposure of captan by personnel participating in an orchard spray program would be 1.94 mg/man/hr. This figure extrapolated from blotter paper patches attached to clothing. Residues of captan on apple and peach leaves were reduced 50% in ten days. No build-up in foliage as the season progressed.

Paris, D. F., et al., report that in their study of microbial degradation and accumulation of pesticides in aquatic systems, captan underwent neither microbial depredation nor sorption because of its rapid hydrolysis in water.

Aquatic Life

Toxicity of Captan to the Dungeness Crab. 1978

Caldwell, R. S., et al., reported that captan did not affect the survival of Dungeness crab zoeae exposed to 30 µg/litre^{-1} during 69 day chronic toxicity test. The larvae were quickly killed at 450 µg/l^{-1}. Delayed moulting did occur at 30 µg/l^{-1}. No deaths to adult crabs exposed for 75 days at 340 µg/l^{-1}. Captan appeared to accelerate the hatching of eggs at concentrations of 100 to 10,000 µg/l^{-1}. At the 3,300 and 10,000 µg/l^{-1} the developing zoeae exhibited some morphological deformity. Under the conditions of the test the half-life of captan appeared to be from 23 to 54 hours. After testing completed, concluded that captan, because of its relatively low toxicity and it high rate of degradation in sea waters, will not pose a hazard to the natural crab populations or crabs in laboratory culture. Furthermore, the prophylactic use of captan as a fungicidal treatment for Lagenidium sp. (a fungus) in larval crab cultures is safe when used at the recommended dosages.

WHO/FAO COMMENTS

The 1978 comments on captan, as released by WHO/FAO from the joint meeting of the international toxicologists regarding captan residues, are as follows:

"EVALUATION FOR ACCEPTABLE DAILY INTAKE"

"Special Studies on mutagenicity

Captan (93%) was investigated for mutagenic activity in vitro in the Ames test, using S. typhimurium strains TA 1535, TA 1537 and TA 1538 with and without rat liver microsomes. Positive results were obtained in the TA 1535 strain only.

In an assay using streptomyces coelicolor, forward mutations, measured as induction of resistance to low doses of streptomycin, were studied. Captan (93% purity) showed a weak mutagenic activity with a plate technique, whereas the spot test was negative. (Carere, et al, 1978).

Captan (> 98% purity) was administered orally to groups of male rats (5 animals/group), in single doses (500, 1000 or 2000 mg/kg), or at 5 consecutive doses (200, 400 or 800 mg/ kg/day). 21 hours after the last administration colchicine (2 mg/kg i.p.) was injected and the animals were sacrificed 3 hours later. From each animal 50 bone marrow cells were observed for chromosomal aberrations. No abnormalities were observed at any dose of captan tested.

In a dominant lethal test, groups of 15 males were treated orally with 0, 200 or 600 mg/kg captan per day for 5 successive days. Then each male was mated with one untreated female. Replacement of the females was made at intervals of 2-4 days and continued for 6 weeks. Fertilized females were killed 12 or 13 days after insemination for examination of uterine contents. Male fertility, mean number of corpora lutea, implants, live embryos, and early and late embryonic deaths were within normal limits throughout the experiment.

Cultures of human diploid skin fibroblasts were incubated in the presence of captan. At doses used, mitotic inhibition and cytotoxicity were observed, however no chromosomal aberrations were induced. (Tezuka, et al., 1978).

Captan (50 wp, 50% technical) was administered i.p. to mice in a dose of 0 or 250 mg/kg. 6, 12, 30 and 54 hours following injection animals were killed and bone marrow cells collected. 5 hours prior to killing, animals were injected i.p. with colchicine (1 mg/kg). The incidents of chromosomal aberrations did not deviate significantly from that in controls. However, 3 metacentric chromosomes were observed in 1001 metaphases from captan treated animals (0/1495 in controls). According to the authors it cannot be stated with certainty that 250 mg captan/kg i.p. does not break chromosomes in vivo because of these unique chromosome rearrangements. (Fry and Ficsor, 1978).

Miscellaneous studies:

Groups of rats were maintained on a diet containing 24, 8 or 4% protein and 0.01 or 0.1% captan for a period of 12 weeks. Captan toxicity was increased in the animals kept on protein deficient diets. Due to protein deficiency the aminotransferase activities were altered. The fructose diphosphate aldolase activity changed significantly as a function of both protein deficiency and captan treatment (summary only). (Urbanek-Karlowska, 1977).

Comments:

Positive mutagenicity studies have been noted in several microbiological systems. *In vivo* and *in vitro* cytogenic studies in mammalian systems; as well as a mouse dominant lethal study were negative.

The Meeting endorsed the opinion of the 1975 Joint Meeting (FAO/WHO, 1976 a) that more weight should be attributed to the results of mutagenic tests in mammalian systems than to those obtained from microbial or other non-mammalian systems or isolated cell systems. The available mutagenicity data did not, in the opinion of the Meeting, affect the previously determined Acceptable Daily Intake (AID).

Toxicological Evaluation

Level causing no significant toxicological effect:

Mouse: 7500 ppm in diet equiv. to 1070 mg/kg bw
Rat: 2000 ppm in diet equiv. to 100 mg/kg bw
Dog: 100 mg/kg bw/day
Monkey: 12.5 mg/kg bw/day

Estimate of acceptable daily intake for man:

0-0.1 mg/kg bw/day ".

CAPTAN

RISKS AND BENEFITS

From the scientific evidence available at this time, December 1, 1981, it would appear that the risk to human beings from illness caused by captan is far outweighed by the benefits humans derive from its uses. The contents of this report deal mainly with the scientific toxilogical data that is available on captan, with some references to residues, methodologies, environmental impact, etc. No attempt has been made to quantify the amount of captan used or to estimate the dollar value derived from its use.

The following summarizes the uses of captan which have extended over the past twenty-five to thirty years.

Fruits

- Apples
- Apricots
- Cherries
- Grapes
- Gooseberries
- Peaches
- Pears
- Plums
- Raspberries
- Strawberries

Vegetables

- Carrots
- Celery
- Cucumbers
- Eggplant
- Lettuce
- Onions
- Peppers
- Potatoes
- Spinach
- Tomatoes

Seed Treatment

- Barley
- Corn
- Oats
- Rye
- Wheat
- Rape
- Soybeans
- Sunflowers

- Alfalfa
- Clover
- Douglas fir
- Flax
- Grasses
- Jack Pine
- Norway Spruce
- Red Pine
- Scotch Pine
- Trefoil

- Asparagus
- Beans
- Broccoli
- Brussel Sprouts
- Cabbage
- Canteloupe
- Carrots
- Cauliflower
- Celery
- Cowpeas
- Cucumbers
- Beets
- Lettuce
- Muskmelon
- Okra
- Onions
- Peas
- Peppers
- Potatoes
- Pumpkins
- Radishes
- Rutabaga
- Spinach
- Sugar beets
- Squash
- Swiss chard
- Turnips

Home and Garden

Azaleas
Begonias
Camellias
Carnations
Chrysanthemums
Gladiolus
Hollyhocks
Lilacs
Roses
Snapdragons
Stocks
Spirea

Industrial

Oil-based paints
Lacquers
Plasticizers
Polyethylene products
Rubber products
Rubber coated products
Vinyl products
Wallpaper

Other

Greenhouse bench treatments
Soil treatments
Turf grasses

There is no fungicide available that has such a wide spectrum of application as captan, and while replacements may be found for a specific use or two, it is not likely another such broad spectrum fungicide will be found for many years to come. Captan also contributes to the certain social benefits, such as the quality and availability of certain food products, the variety of foods available, and the viability of the small family farm.

The removal of captan would also result in poorer quality blemished apples, a reduced supply of apples and a reduction in the shelf life of the apples. Pears would also be adversely affected. The impact on peaches, cherries, and plums would also be great, as scab and brown rot would not only reduce the yield of these crops in the orchard, but there would be a reduction in shelf life along with a greater amount of fruit decay. Grey mold and other diseases would greatly reduce the yields and shelf life of strawberries, and they would almost disappear completely from the market. Blueberries and raspberries, if left unprotected, would also quickly disappear from our retail outlets. Grapes could also be harmed. Lettuce, onions and potatoes are protected by captan, and many of our imported fruits and fruit products are dependent upon captan for disease reduction.

For the home and garden use there are no replacement fungicides available which have the wide spectrum control of captan. There are a few compounds available which have a very narrow spectrum of use, but we do not have the toxicological data available on these compounds to say that they would be safer for the public to use. We do have a great deal of data on captan. To the back-yard gardener captan is a very useful fungicide for strawberries, raspberries, apples, plums and grapes, as well as for roses and other flowering plants. Excercising normal precautions and following label directions, no undue risk should be created to the individual applying the compound, or to the casual bystander.

The following list indicates the fungicides available.

Broad-Spectrum

Captan
Benomyl
EBDC's (dikar, polyram and maneb)
Ferbam
Folpet
Thiram

Narrow-Specific Compounds

Captafol
Copper compounds
Dichlone
Dodine
Maneb + Zinc
Sulfur compounds
Ziram

It has been found that captan is broad spectrum, has very low phytoxicity, no resistance has developed, and may be used up to day of harvest, and on some food products going into storage. Benomyl has the problem of resistance developing. EBDC's cannot be used within 30 days of harvest. Ferbam leaves a black residue and acts only as a protectant, having no eradicant properties. Ferbam cannot be applied within seven days of harvest. Folpet cannot be used on apples before the fourth cover spray, and is not too effective against apple scab. Thiram is not an effective scab control material, but is good in controlling summer diseases of apples. Several of these compounds are involved in RPAR proceedings or on the IBT list of compounds still to be cleared.

If captan is removed from use there will be a much greater total amount of fungicide applied, as a greater number of compounds will be needed and, in many cases, greater amounts will have to be used. Captan fits into the IPM program better than a mixed number of fungicides that would have to be used if captan were to be withdrawn.

There is little doubt that captan is and has been one of the most important pesticides that has been used by man. It has contributed a great deal to grower income, human diet, individual satisfaction, and has done so at very little risk to human health or the environment.

CAPTAN
1979 - 1981

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APPENDIX 3

TABLE 1

WHOLE ANIMAL MUTAGENICITY TESTS

TESTS FOR THE DETECTION OF CHROMOSOMAL ABERRATIONS

1. DOMINANT LETHAL ASSAY

REFERENCE	DOSE MG/KG OR PPM DIET	LENGTH OF DOSING (DAY OR WEEK)	ROUTE	SPECIES	RESULT
Epstein & Shafner, 1968	9 mg/kg	1 day	i.p.	mouse	Negative
	500 mg/kg	1 day	p.o.	mouse	Negative
Epstein et al., 1972	9, 12, 15, 30 mg/kg	1 day	i.p.	mouse	Negative
	500, 800 mg/kg	1 day	p.o.	mouse	Negative
Collins, 1972a	50, 100 mg/kg	5 days	p.o.	mouse	Negative
Collins, 1972b	2.5, 5, 10 mg/kg	5 days	i.p.	rat	Questionable
	50, 100, 200 mg/kg	5 days	p.o.	rat	Questionable
	2.5, 5, 10 mg/kg	5 days	i.p.	mouse	Questionable
	50, 100, 200 mg/kg	5 days	p.o.	mouse	Questionable
Kennedy et al., 1975	3, 6 mg/kg	1 day	i.p.	mouse	Negative
Salamon & Smith, 1977	500, 3000, 7000 ppm	8 week	diet	mouse	Negative
Simmon et al., 1977	1250, 2500, 5000 ppm	7 week	diet	mouse	Negative
Tezuka et al., 1978	200, 600 ppm	5 days	p.o.	mouse	Negative

TEST	DOSE REGIMEN	RESULT
2. HERITABLE TRANSLOCATION (MICE)		
Jorgenson & Rushbrook, 1977 (Mice)	2500 & 5000 ppm in diet for 8 weeks	Negative
3. MICRONUCLEUS		
Seiler, 1976 (Mice)	Single dose of 4, 8 & 12 mg/kg	Negative
4. IN VIVO CYTOGENETICS		
Tezuka et al., 1978 (Rats)	Single dose p.o. of 500, 1000 & 2000 mg/kg	Negative
	5 consecutive daily doses of 200, 400 & 800 mg/kg/day	Negative
Fry & Fiscor, 1978 (Mice)	Single dose i.p. of 250 mg/kg	Negative
5. DROSOPHILA		
Kramers & Knapp, 1973 II-III TRANSLOCATIONS, DOMINANT LETHAL	0.2 µl intra-abdominal 0.31% in media	Negative
Valencia, 1977 CHROMOSOMAL REARRANGEMENT Non-Disjunction	2 & 3 ppm in media	Negative

TESTS FOR THE DETECTION OF GENE MUTATION

TEST	DOSE REGIMEN	RESULT
1. COLOR COAT SPOT		
Nguven & Brusick, 1980 (Mice)	100, 1000 & 5000 ppm in diet on days 8 to 12 of pregnancy	Negative
2. DROSOPHILA		
Kramers & Knapp, 1973 SEX-LINKED RECESSIVE	0.2 µl intra-abdominal 0.31% in media	All Negative
Mollet, 1973 SEX-LINKED RECESSIVE	0.2 µl of 1.5 to 80 ppm solution intra-abdominal; 0.15 & 0.3 µl of 3% solution topical application	Negative
Mollet & Wurgler, 1974 SOMATIC CELL MUTATION (larvae to adult)	0.78 & 1.45% in media	Negative
Valencia, 1977 SEX-LINKED RECESSIVE	2, 3 & 2000 ppm in media	Negative

COMMENTS ON THE MUTAGENICITY DATA DERIVED FROM BACTERIA

THE USE OF MUTAGENICITY DATA DERIVED FROM BACTERIA MUST BE SERIOUSLY QUESTIONED AS A BASIS FOR REGULATORY ACTION DUE TO THE SUBSTANTIAL GENETIC AND METABOLIC DIFFERENCES BETWEEN BACTERIAL AND MAMMALIAN CELLS. These include:

- The lack of a nucleus, nuclear membrane, nucleosome structures, and other cellular organelles in bacteria (Stanier *et al.*, 1963; Cleaver, 1978).
- Varied pathways for the metabolism of chemicals.
- The differences in organization and structure of DNA including the lack, in bacteria, of repetitive sequences (Davidson & Britton, 1979), histones, and other proteins associated with DNA (Cleaver, 1978).
- The presence of different mechanisms for the repair of genetic damage (Hanawalt *et al.*, 1979).
- Different mechanisms of genetic regulation (Monahan & Hall, 1974).
- Differences in the size of the DNA replicating units or replicons (Hanawalt *et al.*, 1979).

APPENDIX 5

RATIONALE FOR THE RECOMMENDATIONS OF MARCH 31, 1981 ON THE STATUS OF CAPTAN

On March 31, 1981 the Health Protection Branch recommended to the Federal Department of Agriculture measures to reduce human exposure to the fungicide Captan. These recommendations, listed on the last page of this document, were based on new toxicological evidence of potential adverse effects on health.

HISTORICAL TOXICOLOGICAL DATA

A major portion of the original toxicological testing used to support the registration of Captan was performed by Industrial Biotest Laboratories (IBT). All of these studies are invalid or seriously flawed. Registrants have been informed of their status and of the need to replace these with valid, alternate or replacement studies.

In 1974, the maximum residue limits for Captan were revised downward, for some foods, in response to toxicological evidence (non-IBT) of fetotoxicity in the hamster and monkey. Rhesus monkeys dosed orally with 12.5 mg of Captan per kg body weight on days 22 to 32 of gestation did not show effects on the 84-day foetus, while after 25 mg/kg for the same period abortions occurred in 3 out of 7 animals. Allowing that human beings might conceivably be as much as 100 times as sensitive as the most sensitive test species, an acceptable daily intake (ADI) of 0.125 mg/kg/day was endorsed by the World Health Organization (WHO). Estimated food residues and food consumption in Canada indicated that human exposure via food was significantly below the WHO guideline.

Captan appeared to be teratogenic in some studies using the hamster and rabbit. However, other studies with these species failed to confirm this observation.

.../2

Bacterial and mammalian cell culture assays indicated that Captan had mutagenic potential. Tests for heritable mutations in whole animals were inconclusive. Captan was not a potent agent with respect to acute toxicity, measured as the single dose lethal to 50% of the treated animals. Fetotoxicity occurred at lower doses than any other adverse effect.

NEW TOXICOLOGICAL DATA

A new study submitted by a registrant January 20, 1981 clearly demonstrated the induction of tumours in the small intestine of mice fed high doses of Captan, confirming previous suggestive findings in a bioassay performed in 1978, by the U.S. National Cancer Institute (NCI).

In the new study both benign and malignant neoplasms were observed in 25 to 52% of the treated animals at the three dose levels and in both sexes compared with the incidence of 2.7-2.8% in the control group. A few of the malignant tumors had metastasized, establishing new sites of malignant growth in other organs.

It is recognized that the very high doses used could conceivably overwhelm normal metabolic functions, and fail to adequately represent the human situation. However, no data indicating any such abnormal metabolic effect are available at present.

Captan appears to be non-tumorigenic in the rat, both in an NCI study and in a second study currently in progress by a second registrant. No data comparing the absorption, distribution, metabolism or excretion of Captan in the rat, mouse and human are available for the purpose of assessing the relevance of the animal models.

.../3

The usefulness of the mouse in carcinogenicity bioassays has been severely criticized by some researchers. Certain strains of mice have a high spontaneous incidence of tumours of the lymphatic system, liver, lung and mammary gland, suggesting that the mouse may be uniquely prone to tumour development at these sites. However, unlike these sites, the natural background incidence of intestinal tumours in mice is generally low. Further, the naturally-occurring lesions are generally benign polyps, while the Captan-induced tumours in the recent study included malignant tumours with metastases.

Reports of experimentally induced tumours in the small intestine of mice are rare. In general, compounds that produce tumours of the small intestine in the mouse are potent carcinogens that have been shown to produce tumours in other organs of the mouse and in other species.

According to the revised criteria (1979) of the International Agency for Research on Cancer, the test results in mice indicate that Captan should be regarded for practical purposes as if it were carcinogenic to humans.

Neither of the mouse cancer studies demonstrated a "no-effect" level, as increased tumour incidence was observed at all of the doses tested. Therefore, an acceptable daily intake can no longer be estimated for Captan. Mathematical extrapolation of the dose-response relationship cannot be used to indicate a "virtually safe" dose, since the available data do not provide any information on which to base the selection of an appropriate model.

HUMAN EXPOSURE

No epidemiological studies adequate to assess any potential health effects of Captan exposure to man are available.

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Monitoring studies conducted by the Health Protection Branch between April '80 and January '81 detected residues of Captan in 66 (51 domestic and 15 imported) samples out of a total of 492 (301 domestic and 191 imported) samples. Most of the positive samples could be accounted for by both domestic and imported apples and strawberries, imported grapes, and domestic raspberries. Fifty-five of the 66 positive samples contained residues of less than 1 ppm, considerably below the existing tolerances. No samples analyzed exceeded the residue limits, the highest value found being only 4.31 ppm. If the maximum residue limits are not reduced, exposure to Captan could legally increase substantially.

Estimates of the daily exposure rate of spray operators indicated that the amount of Captan received via this route may already be of the order of magnitude between 0.1 and 1.0 mg/kg body weight/day.

In addition to the Captan-containing products specifically registered as "domestic class" for use in and around dwellings, this fungicide is used in a variety of products such as paint, wallpaper and glue. Exposure estimates from such uses are not available.

SUMMARY:

1. A new cancer study indicated induction of intestinal tumours in mice by Captan, confirming an earlier NCI study which suggested similar effects.

2. Neither of the cancer studies in mice demonstrated a "no effect level" at which cancer induction did not occur.

.../5

3. There was no evidence that Captan had or had not caused cancer in humans.

4. Estimated exposure to Captan based upon monitoring data is of the order of 0.005 mg/kg body weight/day, some 50-fold lower than the theoretical maximum permitted under the law.

5. Estimates of exposure rates to spray operators indicated that the amount of Captan received via this route is between 0.1 and 1.0 mg/kg body weight/day.

6. It is the policy of the Health Protection Branch to reduce human exposure to potential carcinogens to the lowest practicable level. Therefore, on March 31, 1981 the Federal Department of Agriculture was informed in writing of the following recommendations:

   (1) All registrations of Captan-containing products sold for use in or around a dwelling be discontinued.
   (2) All registrations of products containing Captan for use on foods or food crops require that foods sold at the retail level be free of Captan residues as determined by the official method.
   (3) Provinces be asked to regulate and educate applicators of Captan.

The letter stated that the Health Protection Branch is prepared to re-examine the recommendations if new scientific evidence becomes available.

Health Protection Branch
May 27, 1981

APPENDIX 6

PESTICIDES CONTROL PROGRAM

IN

ONTARIO

CAPTAN

JANUARY 1982

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I REGULATORY PROCEDURES FOR PESTICIDES

1) FEDERAL ROLE

Pest control products are regulated under the Pest Control Products Act; and the conditions under which the products are to be sold and used are set forth in a registered use pattern for each product. All the information outlined in the conditions of registration are incorporated into the label to assist in the safe and effective use of the product by handlers and users. Each pesticide product is identifiable by a code in the registered products list and has a P.C.P. number specific to the product and its trade name.

The application for registration of a product is submitted with sufficient scientific data to allow evaluation of the product with respect to efficacy and safety by Agriculture Canada, Fisheries and Environment Canada, and Health and Welfare Canada. The registration procedure is very complex and takes into consideration the data on efficacy, residues, tolerance levels and environmental impact reflecting differences in soil, climate, use areas and cultural practices. The hazards associated with the manufacturing, using, and the hazards to non-users and non-target areas or organisms. Notes on toxicity, handling and disposal are reviewed. The health aspects include exposure routes, sub-clinical effects, residues and tolerances for food. Also, tissue storage, metabolism, reproduction, teratogenicity, mutagenicity and carcinogenicity are considered with regard to registration.

The goal of this process is to establish an acceptable use pattern for the active ingredient and to set forth the conditions under which the products may be sold and used. Registered products are subject to re-evaluation on the basis of experience, new data or alternative product availability.

2) PROVINCIAL ROLE

In Ontario, the Ontario Ministry of the Environment administers the Pesticides Act and Regulations. It is the goal of the Ministry of the Environment to promote the safe use and sound management of pesticides. The (Ontario) Pesticides Act is based upon the premise that the distribution, transportation, storage and use of pesticides are not automatic rights but are privileges which must be earned. Each individual must exercise responsibility in the handling of these products for his own safety, and also for that of those around him, and for the environment as a whole.

All pesticide products sold in the Province of Ontario must be classified and assigned to a schedule, and the subsequent marketing and use of each product must be in accordance with the regulations relating to the classification. Six schedules exist and are briefly explained later in section III. A function of the Ontario Pesticides Advisory Committee is to classify all such products. The resulting classification, when published in the Ontario Gazette, becomes an amendment to the regulations under the Pesticides Act.

Before classification a pesticide must be registered under the Federal Pest Control Products Act. The Ontario classification system takes into account the formulation as marketed when considering toxicity, but only the active ingredient when considering persistence of parent compounds or their metabolites. Specific use patterns relating to environmental impact or to the humaneness of pest animal control are also considered.

The mechanism is in place under the Pesticides Act to appropriately control the sales and use of all pesticides products. Licences are required to sell pesticide products. Further, licences are required to operate an extermination business and to perform land, water, and structural exterminations, unless such individuals are exempt under the Regulations.

The exemptions for land, water, and structural exterminations are related specifically to the classification of pesticides. The classification of pesticides channels products in areas where they are necessary and into the hands of individuals who can safely and effectly use them. The restricted and more toxic products are only allowed for use under permit and by licenced individuals. The commercial and agricultural products are allowed for use by licenced applicators and agriculturalists. Products, allowed for domestic use or, for use on one's own premise or that of one's employer, are lower in concentration of the active ingredient and total volume than commercial products. Also, they have specific label instructions for domestic use which will not constitute an environmental and/or human health problem for the general public.

Applicants for exterminator's licences are supplied with extensive study and resource material pertaining to their licence application. A Pesticide Safety Handbook is included in this material and individuals are encouraged to keep the manual as a handy reference in their day to day activities. The handbook covers various topics including safety precautions, protective equipment, emergency action, first-aid procedures, and information on the classes of chemicals and their toxicity. Additional publications prepared by the Ministry of Agriculture and Food are supplied and these outline recommended control practices in the production of food commodities.

Applicants are required to pass an examination before licences are issued. Candidates are examined on their knowledge of the legislation, safety procedures and protective equipment, proper storage of chemicals, and the toxicity and application techniques for specific pesticides pertaining to their licence.

In addition, permits for land, water and structural exterminations are required under the Pesticides Act in a number of situations. These include: (1) use of Schedule 1 pesticides, (2) aerial application of all Schedule 1, 5 and hormone-type Schedule 2 herbicides; and (3) use of any pesticide by an individual not otherwise licenced or permitted to do so under the Act.

Five classes of vendor licences including wholesale, limited wholesale, Class 1 retail, Class 2 retail and Class 3 retail exist under the Pesticides Act. There are strict regulations concerning the sale of pesticides at these outlets and specific instructions for proper storage and display of pesticides. Warning signs must be prominently displayed and the sale or transfer of all Schedule 1, 2 and 5 pesticides must be recorded. Vendor inspections are conducted by Ministry of the Environment district officers periodically to ensure that there is strict adherence to the Regulations.

The licencing of individuals and the issuing of permits provides for the proper application of pesticides according to acceptable use patterns. In addition, prohibitory clauses exist under the Act to correct the misuse of pesticides, primarily through the issuing of stop orders, control orders and the imposition of fines.

Routine checking of vendors, exterminators and other client groups ensures compliance with the Act and Regulations, and keeps Pesticides Control Officers aware of individual and group problems so that they may be solved. Where common sense does not prevail, violators may be prosecuted. If found guilty, they may be fined and have their licence revoked.

Public information and education forms a large part of the program. Information is disseminated through fact sheets, information bulletins, fairs and exhibitions. Seminars, courses, meetings and clinics are also held to help those wishing to obtain a licence and/or to update licencees. In addition, educational extension programs of the Ontario Ministry of Agriculture and Food, the Ministry of Natural Resources and other agencies are complementary and well integrated with the program of the Ministry of Environment.

3. OTHER REGULATORY ROLES.

(i) Health and Welfare Canada. In addition to its review of the health and safety impact of pesticides, Health and Welfare Canada is responsible for the establishment and administration of the residue limits (tolerances) for edible and feed commodities.

(ii) The (Ontario) Occupational Health and Safety Act. The Act provides protection for workers using toxic substances at the work place. Employers are responsible for providing protective devices and equipment, identifying hazards to the employees and training personnel on the safe use of toxic substances.

(iii) The Ontario Water Resources Act.
This Act provides authority for maintaining water quality. Activities under the Act are directed towards detecting and preventing the contamination of lakes, streams and ground water. This Act is administered by the Ministry of the Environment.

(iv) The (Ontario) Environmental Protection Act. This Act provides protection and conservation of the natural environment by prohibiting individuals from discharging or depositing any contaminant into the natural environment. Under the Act, the term "contaminant" includes solids, liquids, gases, odours, heat, sounds, vibrations, radiation or combinations of any of them resulting directly or indirectly from the activities of man. This Act is administered by the Ministry of the Environment.

II CAPTAN

Common Name:	Captan
Trade Name:	Orthocide
Chemical Name:	cis-N-Trichloromethylthio cyclohex-4-ene-1,2-decarboxyimide

The fungicide captan was first introduced in 1949 by the Standard Oil Development Company. In 1951, the Standard Oil Development Company was issued a patent for captan. In 1955 Esso was also issued a patent. Currently, Chevron Chemical Company and Stauffer Chemical Company jointly manufacture captan in the United States. In turn, captan is sold by these two companies to licenced wholesale vendors in Ontario for formulation and distribution to licenced retail vendors. Ninety-five percent of the active ingredient would be supplied by these two companies. Approximately five percent also come from Israel and is supplied to Interprovincial Co-operatives for formulation and distribution to the retail trade.

In Ontario the main licenced formulators and wholesale distributors of pesticide products containing captan are Chipman Chemicals Inc., Green Cross Products, Interprovincial Co-operatives Ltd., Wilson Laboratories Ltd. and Later's Chemical Ltd.

Captan is used primarily as a non-systemic fungicide to control fungi and other parasitic plant diseases. Captan's fungicidal activity is through contact with the fungi. It is not systemic, i.e., it is not absorbed by and transported through the plant, and so it is not within the plant but is toxic to the pest to be controlled. It has minor uses as a textile preservative and is an industrial additive in paints, lacquers, wallpaper, rubber products, etc., to control fungal growth.

Captan is marketed in various formulations: dust, emulsifiable concentrate, suspension, solid, and powders. Captan as an active ingredient in different formulations varies in concentration from 5% to 80% of the product.

III ONTARIO CLASSIFICATION OF PESTICIDE PRODUCTS

1) Pesticide Products Containing Captan

The classification of pesticide products containing captan as an active ingredient are as follows:

Schedule 2 - all commercially labelled pesticide products regardless of concetration of captan.

Schedule 3 - all domestic captan products containing greater than 5% captan.

Schedule 4 or 6 - all domestic products containing equal to or less than 5% captan.

2) SUMMARY OF ONTARIO CLASSIFICATION PESTICIDES

PESTICIDE CATEGORY	SCHEDULE	CRITERIA	SALES OUTLET	USED BY
RESTRICTED	1	V. H. TOXIC V. H. HAZARDOUS V. H. PERSISTENT	LICENSED	LICENCED UNDER PERMIT
	5 (INSECTICIDES)	V. H. Toxic V. H. HAZARDOUS V. H. PERSISTENT	LICENSED	SAME AS SCHEDULE 1 EXCEPT NO PERMIT OR LICENCE FOR AGRICULTURIST
PEST CONTROL INDUSTRY & AGRICULTURE	2	H. TOXIC H. HAZARDOUS H. PERSISTENT	LICENSED	LICENSED APPLICATOR OR AGRICULTURIST
CONSUMER, PEST CONTROL INDUSTRY & AGRICULTURE	3	M. TOXIC M. HAZARDOUS M. PERSISTENT	LICENSED	HOMEOWNER LICENSED APPLICATOR & AGRICULTURIST
UNRESTRICTED	4	R. INNOCUOUS	NO LICENCE APPROVED	REQUIREMENT SINCE CONTAINER
CONTAINER RESTRICTED	6	R. INNOCUOUS	LICENSED (LARGE CONTAINER)	HOMEOWNER, LICENSED APPLICATOR & AGRICULTURIST

NOTE: PERMIT REQUIREMENTS

- SCHEDULE 1
- SCHEDULE 1, 5 OR 2 (HORMONE TYPE HERBICIDES) APPLIED BY AIRCRAFT
- AQUATIC APPLICATIONS
- FUMIGATION WITH GAS
- A PERMIT MAY BE GRANTED, IF JUSTIFIABLE, TO A PERSON TO USE A PESTICIDE NOT OTHERWISE AVAILABLE TO HIM.

APPENDIX 7

AGRICULTURAL NEED AND STATISTICS
ON THE USE OF
CAPTAN IN ONTARIO

FEBRUARY 1982

Information supplied by the courtesy of Dr. R. Frank

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INTRODUCTION

The Ontario Ministry of Agriculture & Food conducts research into pesticide use, develops recommendations on their uses and advises on safety and application.

The fungicide, captan is of paramount importance in the production of many agricultural crops in Ontario for the following three basic uses:

1. protection of seeds and seedlings
2. protection of pome, stone and small fruit.
3. protection of foliage and flowers of ornamentals.

Seed of most crops are treated with fungicide to prevent seed decay. It is estimated that annually 50,000 metric tonnes of seed are treated with 40 mt[1] of captan, most by seed houses. This volume of seed represents only a small portion of the total seed used annually in agricultural production in the Province of Ontario. Minor amounts of captan (1.2 mt.) are used to protect seedlings and transplants.

Captan is a major fungicide in the production of pome, stone and small fruit, largely because in 30 years of use fungal resistance has not arisen. This is not the case with many of the alternative fungicides available. Captan is and will be central to present and future successful fruit protection programs. The quantity of captan used on fruit in Ontario is approximately 186 mt.

Captan is a valuable fungicide in the protection of commercially produced ornamentals and for this use approximately 10 mt. are used annually.

Captan is a valuable fungicide to the home owner who wishes to produce vegetables, fruit and ornamentals. The quantity used for these purposes is estimated at around 10 mt. The total use of captan in Ontario was estimated at 248 mt. for the base year 1980.

No residues of captan were found on several vegetables tested, nor was any expected from seed or seedling treatments. Residues on fruit were identified but in all cases these were well below the tolerances set out under the Food and Drug Act & Regulations. Mean residues of apples and strawberries were below 1.0 mg/kg and below 5.0 mg/kg for cherries and peaches. The highest individual sample residues were below 10 mg/kg where tolerances were 25 to 40 mg/kg. It has been shown that between 70 and 90% of residues can be removed from fruit by washing and is destroyed by cooking.

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[1] metric tonne

SEED & SEEDLING PROTECTION

Two techniques are employed to protect seeds or seedlings from fungal attack. These consist of:

(a) Routine protection by treating the seed.

and (b) Emergency protection by treating the seedling or drenching the soil.

(A) SEED TREATMENTS - Almost all commercial seed supplies are treated with the fungicides captan or thiram to prevent seed decay and the damping-off of emerging seedlings (Table 1). Other fungicides (eg. metiram, maneb, carbathin and TCMTB) are available for field crop seeds but are not as widely used as captan and thiram on seeds as a whole. For the most part seed is treated commercially by the seed companies either in Canada or the U.S.A. Seed treatments are often combined with other proceedures to combat:

(a) seed-borne diseases by using the hot water treatment as with cole crops, egg plants, peppers and tomatoes.

or/and (b) soil-borne diseases by soil sterilization with steam or fumigant especially in transplant production of cole crops, eggplants, peppers and tomatoes and in the commercial greenhouse production of tomatoes and cucumbers.

Normally captan or thiram is mixed with seed at the rate of 0.6 to 1.0 g active ingredient per 1 kg of seed. Table 1 gives an estimiate of the amounts of captan used annually on seed supplies needed in the Province of Ontario based on 1980 figures. Approximately 50,000 metric tonnes of seed appears to be treated annually with around 40.5 metric tonnes of captan (active ingredient).

TABLE 1 The use of captan as a seed treatment in Ontario 1980.

Crop	Main fungicide	Seed purchased annually (mt)	Rate captan (g/kg)	Approximate amount captan (ai) used(kg)
Asparagus	thiram	-	-	-
Alfalfa - clover	not treated	-	-	-
Beans - white	captan	1,600	1.0	1,600
soy	captan	19,000	1.0	19,000
lima	thiram	3.6	-	-
snap	thiram	260	-	-
Cole crops	thiram	0.9	-	-
Cucumbers	captan or thiram	8.8	0.6	2.8
Carrots	captan or thiram	4.6	3.0	7.0
Cereals	thiram	-		
Corn - field	captan or thiram	18,000	1.0	9.000
- sweet	captan	251	1.0	251
Lettuce	not treated	0.15	-	-
Eggplant, pepper	captan or thiram	0.23	0.6	0.07
Radish, rutabaga	thiram	8.5	-	-
Peas	captan or thiram	1,200	1.0	600
Potato	captan or thiram	36,000	0.6	10,000
Spinach	captan or thiram	4.2	0.6	1.3
Onions, beets	thiram	-	-	-
Tomatoes	thiram	1.3	-	-
			TOTAL APPROX:	40,500

Captan is a particularly valuable fungicide that has not been associated with skin irritation or other problems among the users. Thiram on the other hand has caused skin irritation and dermatitus among those handling the treated seed.

(B) SEEDLING TREATMENT - Occasionally seedlings being raised for transplants are affected by damping-off organisms that topple the plants at ground level. This may occur inspite of seed treatments, soil sterilization and controlled watering. In these cases a fungicide is sprayed directly on the seedlings. In thecase of eggplant and peppers, captan or zineb is recommended to arrest further spread of the disease. With tobacco seedling, benomyl, captan or a mixture of the two is recommended (Table 2). Benomyl provides good control of the more common Rhizotonia damping-off fungus while it is ineffective against Pythium species. Captan although less effective than benomyl on Rhizotonia is effective against Pythium. An estimate of the amount of captan used in 1980 to spray seedlings is around 0.4 metric tonnes.

(C) SOIL DRENCHES - Captan is used as a seedbed drench in the production of seedlings for transplants and in the commercial production of greenhouse crops where soil-borne diseases affect seedlings (Table 2).

In the control of wirestem among cole crops captan can reduce the incidence when soil is drenched following seeding at 1 kg active ingredient per 400 m^2 of seedbed surface. In the field this disease can be controlled by cultural practises and good management. The damping-off of eggplant and peppers can also be controlled by similar soil drenches with captan.

In the commercial production of cucumbers and tomatoes, areas of soil where damping-off fungal diseases are prevalent can be dusted or drenched with captan, ferbam or oxine benzoate.

TABLE 2 Seedling treatments and soil drenches with captan in Ontario 1980

Crop	Fungicides	Seedbeds & Greenhouse (ha)	Approximate Amount of captan a.i. (kg)
1. Seedling Production			
Eggplant	captan & zineb	0.50	2
Peppers	captan & zineb	1.0	4
Tobacco	captan & benomyl	140	400
2. Seed Drench			
Cole crops	captan	12.0	50
Eggplant & peppers	captan	1.5	4
Greenhouse cucumbers	captan, ferbam & oxine benzoate	100	150
Greenhouse tomatoes	captan, ferbam & oxine benzoate	400	600

---

[1] 10% area treated

It is estimated that around 0.8 mt of captan is used annually for this purpose (Table 2).

RESIDUES - No residues of captan have been found on the food produced as a result of seed or seedling treatments nor is any expected. Food & Drug tolerances range from 2 to 40 mg/kg on vegetables (Table 4).

TOPICAL TREATMENT OF VEGETABLE AND CASH CROPS

The O.M.A.F. makes no recommendation for the topical use of captan on vegetables or cash crops, although, registrations exist that permits its use. No residues have been found in the following vegetables grown in the Province of Ontario to the limit of detection (<0.01 mg/kg): asparagus, cabbage, cauliflower, cucumbers (field and greenhouse), peppers, potatoes, sweet corn and tomatoes (field and greenhouse). The Food & Drug Act & Regulations permit the following residues on these crops (Table 3):

	mg/kg
Asparagus	0.1 (negligible residue)
Cabbage	2
Cauliflower	2
Cucumbers	25
Peppers	25
Potatoes	25
Sweet Corn	2
Tomatoes	25

TOPICAL TREATMENTS FOR FRUIT PRODUCTION

ONTARIO PRODUCTION - 1980 The cash farm sales in 1980 for fruit grown on Ontario farms was $99,048,000. These sales represented 40.3% of the total receipts from the farm sale of fruit across Canada. This volume of sale represented 2.3% of the total cash farm sales generated in the Province of Ontario for 1980. The estimated farm production of fruit during 1980 was 307 x 10^3 metric tonnes (Table 4), a volume that is in no small way dependent on the control of foliar and fruit diseases and especially apple scab and fruit rots with captan.

Imports of this same list of fruit amounts to 45.8% of the domestic production (Table 5) revealing that Ontario could greatly increase its production in these commodities to reduce imports. Only 16,751 mt of fruit or 5.5% of the total production of fruit is exported (Table 6), another area where increased production could be effected to the benefit of the Province.

DISEASE CONTROL - The Province of Ontario is endowed with a moist climate that promotes the production of diseases on fruit. Scab is the most devastating disease of apples and pears, while fruit rots associated with ripening can ravish the production of stone and small fruits. In some years quality of product is seriously affected, because of wet weather making fruit protection difficult. In this respect all purpose fungicides like captan, and the ethylene-bis-dithio-carbamates are indispensible if Ontario is to continue growing fruit.

Varieties of the many fruits grown in the Province are not resistant to the ravishes of the many fungal diseases affecting their production nor is there any indication that resistance can be introduced into these crops in the foreseeable future. While some of the diseases can be be slowed by good orchard sanitation, they cannot be stopped and the major control mechanism is through the use of fungicides.

FUNGICIDES - The appearance of tolerance and resistance to current day fungicides has thrown recommendations on fungicide use into disarray. Each fungicide exhibits its own biological characteristics which may or may not limit its use as can be seen from the classification given here for those commonly used in fruit production.

1. Broad spectrum activity
    (1) Multisite Action
    - captan
    - metiram
    - mancozeb-dinocap
    - maneb
    - ferbam
    - folpet

    (2) Single site action
    - benomyl
    - thiophanate-methyl

2. Narrow spectrum activity
    (3) Multisite action
    - captafol
    - dichlone
    - dodine
    - mancozeb
    - sulfur
    - zineb

TABLE 3 Food and Drug Act & Regulations

Common	Maximum Residue Limit ppm	Foods
Captan	40	Apricots, celery, cherries, grapes, leeks, lettuce, mangoes, onions, peaches, plums, shallots, spinach.
	25	Apples, avocadoes, beans, blackberries, blueberries, citrus fruits, crabapples, cranberries, cucumbers, dewberries, eggplants, garlic, loganberries, melons, pears, peppers, pimentos, pineapple, potatoes, pumpkins, quinces, raspberries, rhubarb, strawberries, squash, tomatoes
	2	Almonds, beets, broccoli, Brussels sprounts, cabbage, carrots, cauliflower, collards, kale, mustard greens. peas, rutabagas, soybeans, sweet corn, turnips.

Table 4 Estimate of 1980 farm production and sale of fruit in Ontario, 1980

Fruit	Area (ha)	Total Production (m.t.)	Marketed Production (m.t.)	Farm value marketed per unit ¢/kg	Farm value marketed Total ($ x 10^3)
Apples	9,896	171,553	171,338	21.8	37,269
Cherries, Sour	914	9,872	9,036	55.0	4,971
" Sweet	536	2,680	2,563	74.5	1,909
Grapes	10,735	60,494	60,218	35.5	21,262
Peaches	3,175	30,618	29,353	44.4	13,021
Pears	1,571	19,798	18,941	33.8	6,394
Plums & Prunes	593	4,441	4,258	56.8	2,420
Raspberries	242	468	468	249.6	1,168
Strawberries	1,167	10,626	10,626	100.1	10,634
TOTAL:	28,831		306,801		99,048

Table 5 Imports of Fruit into Ontario, 1980

Fruit	Quantity (m.t)	Value	
		Total $\$ \times 10^3$	Unit ¢/kg
Apples	21,939	11.720	53.4
Cherries	2,364	3,800	160.7
Grapes	72,626	54,279	74.7
Nectarines	9,918	6,843	69.0
Peaches	8,319	5,305	63.8
Pears	9,074	5,786	63.8
Plums	9,403	8,327	88.6
Strawberries	6,806	7,878	115.8
TOTAL	140,449	103,938	74.0

Table 6 Exports of Fruit from Ontario 1980

Fruit	Quantity (m.t)	Value	
		Unit ¢/kg)	Total $ x 10^3
I. Fresh Fruit	10,407		4,229
Apples	8,362	39.3	3,283
Grapes	1,055	30.7	324
Pears	25	191.9	13
Berries	547	70.6	386
Other Fruit	418	53.3	223
II. Processed Fruit	6,344	153.9	9,763
TOTAL	16,751	83.5	13,992

SPECIFIC FRUIT CROPS

APPLES The major disease of apples is scab (*Venturia inaequalis*) a disease that overwinters in the orchard and is a constant threat to the quality and quantity of crops produced under moist climatic conditions. Sooty blotch (*Gloeodes pomigena*), fly speck (*Leptothyrium pomi*) and pinpoint scab (*Venturia inaequalis*) are late season fungal diseases that may become a threat to fruit quality in some years. The successful apple grower is one who can annually control apple scab and treat for late season diseases when required.

A list of fungicides used on apple diseases appears in Table 7 and Appendix I, and involves all those where captan is part of the recommended list. Resistance of apple scab to benomyl and thiophanate-methyl is now well established in apple orchards across Ontario. Tolerance to dodine has been suspected for years but is not confirmed to date.

The frequency of spraying appears in Appendix I and, depending on weather, can vary between 7 and 13 applications of fungicides per annum. With current recommendations growers are being educated into alternating fungicides and not relying on single compounds. Captan and EBDC compounds are or will become the backbone of all spray programs for apple production in Ontario.

In 1980, 9896 ha of apple-bearing orchards used an estimated 100,000 kg of captan (active ingredient) in 3 sprays or about a third of the normal used in that year (Table 8). Also in 1980, 58 composite samples, representing approximately 70 growers were sampled from Controlled Atmosphere storage and analysed for captan. Residues ranged from not detected (<0.01 mg/kg) to 1.0 mg/kg but with a mean of 0.3 mg/kg (Table 9). The current tolerance for apples under the Food & Drug Act and Regulations is

TABLE 7. Fungicides used to control fungal diseases in the production of apples in Ontario

Broad spectrum activity	Limitations	Days to harvest
captan	None	7
dodine	Resistance is suspected in some orchards	1
benomyl	Widespread resistence identified	1
mancozeb-dinocap	Days to harvest	30
mancozeb	Days to harvest	30
thiophanate-methyl	Widespread resistance suspected	1
metiram	None	7
Narrow spectrum activity		
folpet	Sooty blotch and fly speck control	1
captafol	Early season scab control	-
dichlone	Early season scab control	7
zineb	Sooty blotch and fly speck control	14

Table 8 Estimated amounts of captan used in the production of fruit in Ontario, 1980

Fruit	Area (ha)	Captan (kg/ha)	Captan used (kg)	Number of Sprays of Captan	Possible number of sprays of captan	
					dry year	wet year
Apples	9,896	10	100,000[1]	3	7	13
Cherries	1,450	7	10,000	2	5	8
Grapes	10,735	2	22,000	1	1	2
Peaches	3,175	8	27,000	2	3	4
Pears	1,571	5	8,000	2	3	5
Plums	593	9	6,000	3	3	5
Raspberries	242	8	2,000	2	2	5
Strawberries	1,167	9	11,000	3	4	8
TOTAL:	28,831		186,000			

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[1] Cathy McKay found that 4560 kg captan (ai) was used on 317 ha apple orchard in Durham region in 1981. This represents 142,000 kg for Ontario.

Table 9. Monitoring of Ontario grown fruit collected from Food Terminal Toronto and Inspection Station, Leamington. Apples collected from CA storage.

Fruit	Year	Composite Samples[1]	Captan				
			<0.1	0.1-1.0	1.0+	Mean	Maximum
			← no. samples →			← μg/g →	
Peaches	1980	7	4	3	0	0.29	0.88
	1981	7	0	2	5	2.83	9.00
Apples	1980						
- McIntosh		27	19	8	0	0.14	1.00
- Red Delicious		21	18	3	0	0.07	0.44
- Northern Spy		3	3	0	0	<0.01	0.01
Strawberries	1980	5	1	3	0	0.32	0.76
	1981	14	3	5	6	0.87	2.40
Sweet Cherries	1980	5	1	3	1	0.58	1.70
	1981	5	1	1	3	1.91	4.90

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[1] Apples represent mainly single producers. Peaches, cherries and strawberries represent composites of 5 to 10 producers.

[illegible] mg/kg (Table [illegible]).

APRICOTS The production of apricots is currently so small in Ontario as to not appear separately in the O.M.A.F. statistics for the Province. The production of apricots is however, very dependent on fungicides to control blossom blight and brown rot *(Monilinia fructicola)*. This can be observed in the spray schedule found in Appendix II. In Ontario only sulfur or captan alone or with benomyl are recommended for the control of these diseases.

No residue data are available on apricots per se but it is expected that residues will be similar to those found on peaches (see later section). Current Food & Drug Regulations permit up to 40 mg/kg of captan in the marketable fruit (Table 4).

SWEET AND SOUR CHERRIES The major fungal diseases of cherries are leaf rot *(Coccmyles hiemalis)* and brown or fruit rot *(Monilinia fructicola)*. The producer must control these diseases if he is to remain in business. There are no indications that resistance exists that can be incorporated into present day varieties.

A list of fungicides used on cherries appears in Table 10 and Appendix III and involves all those where captan is a part of the recommended list. The major fungicides used in the production of cherries are captan and sulfur. These form the backbone of any spray program in Ontario. Captan is the preferred material and 2 of the 6-8 fungicide sprays applied annually are with captan. In 1980, 914 ha sour cherries and 536 ha of sweet cherries received an estimated 10 metric tonnes of captan (ai) to control diseases (Table 8).

Table 10 The list of fungicides and their limitations recommended for fruit production in Ontario

Fruit	Fungicide	Limitations	Days to harvest
Sweet and Sour Cherries	captan	none	1
	sulfur	none	1
	dichlone	Not effective on leaf spot	3
	folpet	Not used on sweet cherries	1
	thiophanate-methyl	Must be alternated to avoid resistence	1
	benomyl	Used with captan only	1
	dodine	Not used on sweet cherries	7
	ferbam	For post harvest diseases only	4
Peaches and Nectarines	captan	None	1
	sulfur	None	1
	dichlone	Used pink through bloom stages only	-
	benomyl	Alternated with captan or sulfur	1
	thiophanate-methyl	Alternated with captan or sulfur	1
	dichloran	Only effective on Rhizopus, not brown rot.	1
Pears	dodine	Tolerance to scab is suspected	7
	captan	None	7
	mancozeb-dinocap	Days to harvest	30
	benomyl-mancozeb	Alternate to avoid resistance to benomyl	30
	zineb	Only effective against sooty blotch	7
Plums and Prunes	captan	None	1
	sulfur	None	1
	captan-benomyl	None	1
	thiophanate-methyl	Alternate to avoid resistance	1
Raspberries	benomyl-captan	Benomyl only used with captan	1
	captan	None	1
	thiophanate-methyl	Alternate with captan	
Strawberries	benomyl-captan	Benomyl only used with captan	1
	captan	None	1
	anilazine	Days to harvest	5
	thiophanate-methyl	Must be alternated to avoid resistence	1

The weather conditions at harvest time control the incidence of fruit rot and influence the number and closeness to harvest of sprays. In 1980 conditions were drier than 1981 and as a consequence the mean residue of captan on cherries was 0.6 mg/kg as compared to 1.9 mg/kg in 1981 (Table 9). The Food & Drug Regulations permit up to 40 mg/kg on the marketable fruit (Table 3).

GRAPES Captan is an important fungicide in the production of grapes and it is currently used in the early part of the season to control dead arm (*Fusicoccum viticola*) and downy mildew (*Peasmopara viticola*) (Appendix IV). Folpet or captan is recommended for dead arm while the EBDC fungicides or captan are used to control mildew.

The 10,735 ha of grapes receives about 22,000 kg of captan annually (Table 9). Residues have not been determined but are predicted to be below 1.0 mg/kg and likely below 0.1 mg/kg. The Food & Drug Regulations permit up to 40 mg/kg (Table 3).

PEACHES AND NECTARIES Captan is a major fungicide in the production of peaches for the control of blossom blight and brown rot of the fruit (*Monolinia fructicola*). Captan and sulfur are or will be the main stay materials in the production of peaches with captan being the preferred material. The list of fungicides used in the production of peaches appears in Table 10 and Appendix V. To avoid resistance developing to benomyl and thiophanate-methyl, these materials are only used in combination with captan or sulfur as alternating fungicides. Captan was used at least

2 times on peaches in 1980 and an estimated 27,000 kg was applied to the 3175 ha of producing orchards in Ontario (Table 8).

Composite samples of peaches analysed in 1980 and 1981 contained mean residues of 0.29 and 2.83 mg/kg respectively. Maximum residues of 9.0 mg/kg were found in 1981; a wetter harvest period than 1980 (Table 9). The Food & Drut Act and Regulations permit up to 40 mg/kg on marketable fruit (Table 3).

PEARS Captan is an important fungicide for the control of scab (*Venturia pyrina*) leaf rot (*phyllosticta pyrina*) and sooty blotch (*Gloedes pomigena*) in the production of pears in Ontario. A list of fungicides used in pear production appears in Table 10 and Appendix VI, where captan is part of the recommended list. Resistance to benomyl and dodine have not been identified but could arise from use of these materials to the exclusion of others. Captan and mancozeb-dinocap are the only fungicides that form the backbone of a successful future program. The latter mixture is limited because of the time interval to harvest, especially on early pears.

It is estimated that 8 m.t. of captan were used on the 1571 ha of pears in 1980 (Table 8). No figures are available for captan on pears but it is predicted that these should not be much above 1 mg/kg. The tolerance permitted is 25 mg/kg (Table 3).

PLUMS AND PRUNES Captan is an important fungicide in the control of brown rot (*Monilinia fructicola*) and leaf spot (*Phyllosticta circumscissa*) of plums. Captan and sulfur forms the backbone to any successful spray program for the production of plums in Ontario. The development of resistance to benomyl and thiophanate-methyl is a constant threat if only these materials are used. A list of fungicides appear on Table 10 and Appendix VII where captan is a part of the recommended list.

It is estimated in 1980 that 6 m.t. of captan was used on the 593 ha of plums frown in Ontario (Table 8). No residue data is available but it is expected to be similar to that for cherries and peaches. The Food & Drug Act and Regulations currently permit up to 40 mg/kg (Table 3).

RASPBERRIES Captan is the only reliable fungicide that can be used against a series of fungal organisms causing fruit rots in the production of many small fruit and especially raspberry. A list of alternatives appears in Table 10 and Appendix VIII. There is the constant threat that resistance could develop to benomyl and thiophanate-methyl unless alternated with captan.

It is estimated that 2 m.t. of captan is used annually on raspberries (Table 8). While no residue data are available it is predicted that residues will be similar to those found on strawberries or cherries. The residue tolerance permitted under the Food & Drug Act & Regulations is 25 mg/kg (Table 3).

STRAWBERRIES Captan is the most important fungicide in the production of strawberries to control Botrytis fruit rot (*Botrytis cinerea*) a devastating disease during wet years. Resistance to benomyl and thiophanate-methyl is a constant threat unless alternated or combined with captan or anilazine. A list of fungicides and their limitations appear in Table 10 and Appendix IX.

It is estimated that 11 m.t. of captan were used on the 1167 ha of strawberries grown in 1980 (Table 8). In 1980 and 1981 composite samples of strawberries were analysed for captan residues. Mean residues were 0.3 and 0.9 mg/kg respectively for the two years, with the highest residues being 2.4 mg/kg (Table 8). These residues are well below the 25 mg/kg permitted under the Food & Drug Act and Regulations (Table 3).

CAPTAN DISAPPEARANCE STUDIES

CAPTAN DISAPPEARANCE FROM FRUIT - During 1981 experiments were conducted on the disappearance of captan from stone fruit and grapes. Fruit was treated at commercial rates using commercial spraying equipment. Fruit samples were collected and harvested at different day intervals following treatment. The results of sampling between Day 0 and Day 15 appear in Table 11. Declining residues were correlated to rainfall in some cases. The rapid decline of residues on sour cherries occurred during an 81 mm rain between Day 3 and 6 and a second rain of 42 mm between Day 9 and 12. The rapid decline in peaches between Day 0 and Day 1 was following a 27 mm rain. Losses of residues from grapes were little affected by rainfall. This work will be expanded in the 1982 season.

TABLE 11 Disappearance of captan from three types of fruit treated with captan at 3.4 kg/ha between mid July and September 1981

Fruit	Period of Study	Captan (ug/g) Initial	Day 1	Day 3/4	Day 9/10	Day 14/15
Sour Cherries	Mid-Late July	5.3	6.0	5.2	0.3	0.1
Peaches	Late July - Early Aug.	9.9	7.3	2.7	2.2	1.7
Peaches	Mid August	12.1	6.5	5.8	4.8	-
Grapes[1]	Late Aug. - Sept.	8.3	7.3	4.9	4.1	3.8
Grapes[1]	Sept.	3.3	4.5	3.1	4.6	3.5

[1] French hybrids

A comparison was made in 1981 between the degradation rates of three types of fungicides on strawberries. Table 12 shows the initial deposit of residue and the application rates. Half life disappearance rates are given and these reflect the stability of the fungicides.

Table 12 Disappearance rates of three types of fungicide applied to strawberries, 1981

Compound	Rate of application (kg ai/ha)	Initial deposit (ppm)	Half-life $t_{\frac{1}{2}}$ (days)
Captan	3.4	6	2.9
Zineb (EBDC)	4.0	7	4.4
Dicarboximides	0.4 to 0.85	0.7	5.3

Washing an aged captan sample (day 14)with 0.25 mg/kg removed 20%, i.e. leaving a residue of 0.20 mg/kg.

CAPTAN REMOVAL In 1981 composite samples collected from the Food Terminal, Toronto were rinsed in cool water and dried on paper towels. Although only a limited number were done in all cases significant amounts of captan were removed (Table 13). With sweet cherries 94% of a 1.9 mg/kg residue was removed. With peaches the removal was 68% and with a single sample of strawberries it was 78%.

TABLE 13 The removal of captan residues from rinsing

Fruit	Composite Samples	Captan (mg/kg) Unwashed	Captan (mg/kg) Washed	Removal (%)
Peaches	6	3.53	1.14	68
Sweet Cherries	5	1.92	0.11	94
Strawberries	1	0.89	0.20	78

In the fall of 1981, a replicated experiment was set up in which apples were dipped in a captan solution (2500 mg/L), allowed to dry for 2.5 days before fruit was washed, wiped, placed in boiling water or various combinations of these procedures. The removal of captan appears in Table 14. Following dipping,apples were kept in a dry cool room until used in the experiment.

Table 14 The removal of captan from apples 2.5 days after dipping

Treatment of apples after dipping in captan.	Ave.wt. of apple (g)	Captan ug/apple		Removal (%)
		Mean	SD	
None	131	1289	113	-
Rinsed (warm water)	133	739	105	43
Wiped (damp paper towel)	134	316	43	75
Rinsed and wiped	131	158	32	88
Boiled (1 min)	129	273	74	79
Rinsed and boiled	135	116	27	91
Wiped and boiled	133	63	38	95

The amount of captan found in rinsing water ranged from 0.8 to 4.4 ug and could not account for that removal. The amounts of captan found in the damp paper towels ranged from 1.2 to 170 ug and again could not account for that removal. No captan could be found in the boiled water to the limit of detection of 0.1 ug.

Experiments on washing and cooking were repeated in two further experiments that appear in Table 15.

Table 15 The removal of captan from apples 2.5 & 4.5 days after dipping

Treatment of apples after dipping	Av.Wt. of apples (g)	Captan µg/apple		Removal (%)	Residue (mg/kg)
		Mean	SD		
Experiment I (2.5 days after treatment)					
None	109	1626	122	-	14.9
Diced	110	1202	413	26	10.9
Diced & cooked	104	105	80	94	1.0
Thorough washing & drying(water)	109	95	23	94	0.9
Thorough washing & drying(detergent)	112	102	41	94	0.9
Experiment II (4.5 days after treatment)					
None	113	1094	275	-	9.6
Diced & cooked	112	17	19	98	0.2
Thorough washing & drying(water)	112	66	21	94	0.6

A thorough washing involved rinsing in warm water and drying with a kitchen towel. These procedures removed 94% of the residue. Diced and cooked removed between 94 and 98% of the residue.

The degradation of captan was followed in water with initial concentrations of 1 and 5 mg/L in tap water at 21 and 4C (Table 16).

Table 16 Breakdown of captan in a water solution.

Time	Solution in tap water			
	1 mg/L		5 mg/L	
	21C	4C	21C	4C
30 min	0.76		4.4	
24 hrs	0.068	0.64	1.32	4.3
120 hrs	<0.002	0.046	0.13	2.1
$T_{\frac{1}{2}}$ (hrs)	8	30	24	120

Half life disappearance appeared to be different between the two concentrations. Where a solution of 850 mg/L was prepared and placed in hot water (140C) residues had declined to 88 ± 16 ml/L in 14 hrs a half life of about 3 hrs. Where a similar solution was boiled S.C. Cl_2 was evolved and no captan could be found in the boiled water (5 minutes).

TOPICAL TREATMENTS IN THE PRODUCTION OF

COMMERCIAL ORNAMENTALS

GREENHOUSE ORNAMENTALS - Captan is one of two to five fungicides recommended for seedling, leaf, stem and root diseases affecting a wide range of ornamentals commercially produced in the greenhouse (Appendix X). Captan is of particular value in controlling diseases of carnations, chrysanthemums and roses, where the choice of alternatives is limited.

ANNUALS AND PERENNIALS - Captan is one of two to five fungicides recommended for the control of foliar and stem diseases of many annual and perennial plants (Appendix XI). Captan is of particular value in controlling stem rot of begonia. The primary alternatives to captan are the EBDC fungicides.

TREES AND SHRUBS - Captan is one of few fungicides recommended for controlling blossom, leaf and twig diseases of a wide range of shrubs and trees (Appendix XII).

VOLUME OF USE - It is estimated that about 10 metric tonnes of captan is used in the commercial production of ornamentals. The same problems exist in these crops where constant use of single fungicides especially benomyl and thiophanate-methyl can give rise to resistance. Breeding resistance to some of these diseases is likely to rank high on developing future varieties.

CAPTAN USE IN HOME GARDENS

In many cases captan is the only fungicide available to the home owner.

SEED TREATMENT - Almost all vegetable seeds used by the home owner are treated with captan (Appendix XIII). The volume of this use is estimated to be less than 1.0 metric tonne.

SEEDLING TREATMENTS AND SOIL DRENCHES - Captan or oxine benzoate are the two fungicides available to the home owner to control damping off fungal infections. These are recommended for many vegetables as a seedling treatment or a soil drench (Appendix XIII). Quantities used are probably less than 100 kg. of captan per annum.

TOPICAL TREATMENT OF VEGETABLES - The only topical treatment on vegetables, where captan is registered for use by home owners is for leaf spot and blight control on carrots. Two alternatives are available - chlorothalonil and maneb. (Appendix XIII). Quantities used are probably less than 100 kg per annum.

TOPICAL TREATMENT OF FRUIT - Only three fungicides are available to the home owner in Ontario for the control of diseases attacking fruit (Table 14). The same problems of resistance exist with benomyl as occurs in commercial orchards where fungal resistance has been identified. For all fruit a successful spray program must include captan or ferbam or both (Appendix XIV and XV). Benomyl cannot be used on pears.

TABLE 17 Fungicide and their limitations on fruit grown in home gardens.

Fruit	Fungicides	Limitations
Apples and Peaches	benomyl	must be alternated with captan or ferbam
	ferbam	none
	captan	none
Pear	ferbam	none
	captan	none
Cherry and Plum	benomyl	if leaf spot is severe use ferbam or captan
	ferbam	none
	captan	none
Grape	captan	none
	copper compounds	build up copper residue in soils
	folpet	not as effective as captan
Raspberry	lime sulphur	not effective on fruit rot
	captan	none
	benomyl	not effective on anthracnose and spur blight
Strawberry	benomyl	not effective on leaf spot
	captan	none

Captan is the most satisfactory fungicide of three for the control of diseases on grapes and raspberries (Table 14, Appendix XVI). Captan is the only fungicide available to the home owner in the control of leaf spot on strawberries (Table 14, Appendix XVI). Even with fruit rot the only alternative is benomyl. Unfortunately constant use of benomyl on Botrytis fruit rot could result in resistance.

TOPICAL TREATMENT OF ORNAMENTALS - A wide range of fungal diseases can be controlled by captan in the home garden; however, in most cases there are adequate alternatives. See Appendix XVII for details. Probably the greatest use is on roses.

VOLUME OF USE - The total use of captan by the home owner is difficult to calculate. It is estimated at around 10 metric ton.

CAPTAN AND THE AGRICULTURAL ENVIRONMENT

ORCHARD SOILS - During a survey between 1972-1975 to look for metal and pesticide residues, about 20 apple orchard soils were analysed for captan. Sampling occurred in the fall (October) following use during the season. No residues of captan could be found in soil to a limit of <0.01 mg/kg and as a result no further testing was done.

GENERAL INVESTIGATIONS - Over a period of 16 years and analysing up to 8000 samples a year of all types of tissues (animal, vegetable and mineral), no cases of captan, human or animal sickness or untoward residues can be found in our records to show any problems associated with the use of captan.

STREAM WATERS - The mouth of three major streams were sampled during 1981 to monitor for a wide range of pesticides both during regular flow conditions and during storm events. In a number of samples, captan was included in the analysis procedures. To date, no residues to a limit of <0.2 ug/L have been detected (Table 18).

Table 18 Monitoring of captan in three major rivers in Ontario

River	Period of Testing	Number of samples analysed	Limit of detection	Water samples with detectable residues
Grand River	May 13 - Sept 28	9	0.2 ug/L	0
Saugeen River	July - October	3	0.2 ug/L	0
Thames River	May 20 - Oct 20	25	0.2 ug/L	0

APPENDIX I

APPLES

Stages to Spray	Disease	Materials	Notes
A. GREEN TIP up to HALF-INCH GREEN	Apple Scab single application technique	captafol	Apply fungicide before spore release and keep growing leaves coated. For protection until petal fall. Do not prune after application.
	OR		
B. TIGHT CLUSTER PINK	Group A (Season Long)	(1) metiram (2) captan (3) dichlone (4) mancozeb-dinocap (5) mancozeb	Materials in Group C must be alternated with a material(s) in group A. Materials in group A or B can be used in seasonal programs. Be aware that continuous use of any material will increase the chance of tolerance development.
C. FULL PINK			
D. BLOOM PERIOD	Group B (Season Long)	(6) captan-benomyl (7) benomyl plus metiram (8) benomyl plus captan (9) benomyl plus mancozeb	Do not apply benomyl combinations on Golden Delicious, Rome and Stayman. Scab resistance to benomyl and thiophanate-methyl is now established in Ontario. Where control problems occur, change to a chemical in group A immediately.
	Group C (Alternate)	(10) thiophanate-methyl	Where control or injury problems with dodine have been experienced, use one of the other protectants.
	After-infection Spray ("Eradicants")	Use one of: (1) dichlone (2) metiram (3) captan (4) mancozeb-dinocap (5) dodine	Apply eradicant rate of dichlone only once a season. Where control problems with dodine have been experienced, use one of the other eradicants.

APPLES

Stages to Spray	Disease	Materials	Notes
E. CALYX	Scab		Use one of the fungicides recommended above, except for captafol and dichlone. An extra scab spray may be required between Calyx and First Cover spray.
F. FIRST COVER 7 to 10 days after Calyx			
G. SECOND COVER 10 days later			
H. THIRD COVER 10 days later	Group A	Use one of: (1) metiram (2) captan (3) mancozeb-dinocap (4) mancozeb	If scab is controlled in your orchard lower rates can be used. Do not apply benomyl combinations on Golden Delicious, Rome or Staymar.
I. FORTH COVER 10 days later			
J. FIFTH COVER 10 days later	Group B	(5) captan-benomyl (6) benomyl plus metiram (7) benomyl (8) benomyl plus mancozeb	
K. 1. SIXTH COVER 10 days later	Group C	(9) thiophanate-methyl (10) dodine	
K. 2. SIXTH COVER (cont)	Sooty blotch and fly speck	Use one of: (1) captan (2) benomyl plus captan (3) zineb (4) folpet	Repeat application of captan in two weeks. Both captan and benomyl will control Bull's Eye Rot. All materials provide some protection against other storage rots.

APPENDIX 1 (cont.)

APPLES

Stages to Spray	Disease	Materials	Notes
L. SEVENTH COVER Check on timing	Pinpoint scab and storage scab.	Use one of the fungicides recommended for Third Cover.	Do not use fungicides closer than the stated preharvest interval.

APPENDIX II

APRICOTS

TIME TO SPRAY	DISEASES	MATERIALS	NOTES
A. PREBLOOM (When blossom buds show pink) B. SHUCK-SPLIT (when about 50% of shucks have split) C. SHUCK-FALL D. PRE-PICK	Brown rot Blossom blight	Use one of: (1) sulfur (2) captan (3) benomyl plus captan	Apricots are extremely susceptible to brown rot at blossom time and just before picking.

APPENDIX III

CHERRIES (SWEET AND SOUR)

TIME TO SPRAY	DISEASES	MATERIALS	NOTES
BLOOM	Brown rot (stem rot and blossom blight stages)	Use one of: (1) captan (2) sulfur (3) dichlone (4) folpet (5) thiophanate-methyl (6) benomyl plus captan	Spray just before blossom buds open. If wet weather prevails, this spray should be repeated. Do not use dichlone or captan following oil. Do not use folpet on Sweet Cherry. Alternate thiophanate-methyl with any of the first four fungicides.
PETAL FALL	Leaf spot (Sour Cherry only)	Use one of: (1) dodine (2) captan (3) folpet (4) benomyl plus captan	Spray only if rain is forecast between BLOOM and SHUCK. Do not use dichlone or dodine on Sweet Cherry.
SHUCK	Brown rot	Add one of: (1) captan (2) sulfur (3) dichlone (4) folpet (5) thiophanate-methyl	Dichlone is not effective for leaf spot. Do not use dichlone on Sour Cherry. Do not use folpet on Sweet Cherry. Alternate thiophanate-methyl with any of the first four fungicides to delay resistance.
	Leaf Spot	Use one of the fungicides recommended at PETAL FALL.	

APPENDIX III continued

CHERRIES

TIME TO SPRAY	DISEASES	MATERIALS	NOTES
FIRST COVER 12 days after SHUCK	Brown rot Leaf spot	Use one of the fungicides listed under SHUCK. Use one of the fungicides listed under PETAL FALL.	
SECOND COVER 12 days after FIRST COVER	Brown rot	Add one of: (1) captan (2) sulfur (3) folpet (4) thiophanate-methyl (5) benomyl plus captan	Do not use folpet on Sweet Cherry Alternate thiophanate-methyl with any of the first three fungicides to delay resistance.
	Leaf Spot	Use (1) (3) or (5) above or dodine	Do not use dodine on Sweet Cherry.
THIRD COVER	Leaf Spot Brown rot	Add one of the fungicides listed under SECOND COVER.	
PRE-PICK (Sweet Cherry)	Brown rot	Use one of the fungicides listed under SECOND COVER for Sweet Cherry.	Spray each variety just before picking.

APPENDIX III continued

CHERRIES

TIME TO SPRAY	DISEASES	MATERIALS	NOTES
POSTHARVEST	Leaf spot	Use one of: (1) dodine (2) captan (3) ferbam (4) folpet (5) benomyl plus captan	Necessary where leaf spot is a problem. Do not use folpet on Sweet Cherry.

APPENDIX IV

GRAPES

TIME TO SPRAY	DISEASES AND INSECTS	MATERIALS	NOTES
DEAD ARM SPRAYS	Dead arm	Use one of: (1) captan (2) folpet	Cut off vine or arm well below the diseased area. Spray varieties where dead arm is a problem, when new shoots are 1.25 cm to 5 cm long, and again when 10 cm to 15 cm long. Apply at least 1700 L of spray per hectare.
BLOOM	Downy mildew	Add one of: (1) folpet (2) captan (3) metiram (4) mancozeb-dinocap (5) mancozeb	Spray Buffalo, Fredonia, President, Van Buren, French Hybrid and vinifera varieties. If bloom is delayed or if wet weather is expected, repeat the application.

APPENDIX V

PEACHES AND NECTARINES

Time to Spray	Diseases and Insects	Materials	Notes
PINK THROUGH BLOOM	Blossom blight stage of brown rot	Use one of:	Spray when first blossoms are opening (late pink). Repeat at 4-to 5-day intervals if weather is wet.
		(1) captan	
		(2) sulfur	
		(3) dichlone	
		(4) captan-benomyl	Package mix.
		(5) benomyl plus captan	Tank mix.
		(6) thiophanate-methyl	Alternate thiophanate-methyl with one of first two fungicides to delay resistance.
FIRST COVER Spray all varieties about July 6.	Brown rot	When spraying varieties maturing before Redhaven add one of:	
		(1) captan	
		(2) sulfur	
		(3) captan-benomyl	Package mix.
SECOND COVER		(4) benomyl plus captan	Tank mix.
		(5) thiophanate-methyl	Alternate thiophanate-methyl with one of first two fungicides to delay resistance.
HARVEST Just before picking each variety	Brown rot	Use one of:	In wet weather repeat applications between pickings.
		(1) captan	
		(2) sulfur	
		(3) captan-benomyl	
		(4) benomyl plus captan	
		(5) thiophanate-methyl	Alternate thiophanate-methyl with one of first two fungicides to delay resistance.

PEACHES & NECTARINES cont'd....

Time to Spray	Diseases and Insects	Materials	Notes
HARVEST Just before picking each variety.	Rhizopus rot and brown rot	dichloran plus captan or benomyl	
POSTHARVEST TREATMENT	Rhizopus rot (Black whiskers) Brown rot	dichloran plus benomyl or captan	Dip harvested peaches in a suspension. Rates are for 500L of water

APPENDIX VI

PEARS

Time to Spray	Diseases & Insects	Materials	Notes
GREEN TIP	Scab	Use one of: (1) dodine (2) captan (3) mancozeb-dinocap (4) benomyl plus mancozeb	It is important to start scab control early and repeat the spray if weather remains wet. Alternate benomyl and benomyl-mancozeb with full rates of captan. Dodine or mancozeb-dinocap to avoid benomyl resistance.
PREBLOOM As blossom buds show white at tips.	Scab	Use one of: (1) dodine (2) captan (3) mancozeb-dinocap (4) benomyl plus mancozeb	Start control early where scab is a problem. Repeat spray if weather remains wet.
PETAL FALL	Leaf spots Pear scab	Add one of the fungicides listed for Scab under GREEN TIP	If weather is wet extra sprays will be needed for scab control before FIRST COVER.
FIRST COVER	Scab	Add one of the fungicides listed under GREEN TIP.	
SECOND COVER About July 25	Sooty blotch	Add one of: (1) captan (2) zineb	Repeat spray for sooty blotch should be two weeks later.

A DIX VII

PLUMS

Time to Spray	Diseases & Insects	Materials	Notes
PREBLOOM When blossoms show white	Brown rot	Use one of: (1) captan (2) sulfur (3) captan-benomyl (4) benomyl plus captan (5) thiophanate-methyl	To help control brown rot, knock off mummied fruit when pruning. Also, cultivate entire orchard before bloom. Sulfur helps control Eriophyid mites on European plums and prunes. Alternate thiophanate-methyl with full rates of captan or sulfur to avoid resistance. Captan may cause injury under some circumstances. Injury has occurred on Grand Prize, Early Golden, Shiro and Burbank.
SHUCK When most of the shucks are off	Brown rot	Use one of: (1) sulfur (2) captan-benomyl (3) benomyl plus captan (4) thiophanate-methyl	Package mix. Tank Mix.
FIRST COVER 12 days after SHUCK	Brown rot Leaf spot	Use one of the fungicides listed under SHUCK.	
SECOND COVER PRE-PICK	Brown rot	Use one of: (1) sulfur (2) captan-benomyl (3) benomyl plus captan (4) thiophanate-methyl	Spray varieties subject to brown rot, such ad Grand Duke, Lombard, Italian, Reine Claude.

Appendix VIII

RASPBERRIES AND BLACKBERRIES

Time to Spray	Diseases and Insects	Materials	Notes
Bloom	Fruit rots on raspberries	Use one of: (1) captan (1 day) (2) benomyl plus captan (1 day) (3) thiophanate-methyl	Repeat every 7 to 10 days to harvest. Because fungus can become resistant to benomyl and thiophanate-methyl, captan is recommended.

Appendix IX

STRAWBERRIES

Time to Spray	Diseases and Insects	Materials	Notes
1. First Spray when buds are visible in crown	Fruit rot (Botrytis)	Use one of: (1) Benomyl (1 day) plus captan	Early season spraying is essential. Spray every seven to ten days. Reduce interval to three to five days during rainy periods. Captan gives short residual control under wet conditions. Anilazine may cause foliage injury if used soon after a frost.
2. When first buds show white		(2) captan (1 day)	
3. First bloom		(3) anilazine (5 days)	benomyl will also control powdery mildew.
4. 7 to 10 days after first bloom repeat 7 to 10 days later		(4) thiophanate-methyl	
To end of harvest	Fruit rot	Use one of: (1) captan (1 day) (2) benomyl (1 day) plus captan (1 day) (3) thiophanate-methyl (1 day)	If wet weather persists throughout harvest, alternate captan with thiophanate-methyl or use mixture (2).

APPENDIX X Commercial Production of Greenhouse Ornamentals

Disease	Plants	Alternatives
Botrytis	African Violet Begonia Calceoloria Cineraria Cyclamen Hydrangia	benomyl dichloran captan iprodione
	Bedding Plants Snapdragon	chlorothalonil benomyl captan dichloran iprodione
	Bulb Crops	benomyl dichloran captan
Root Rot (cuttings)	Begonia	fenaminosulf ethazole benomyl captan carbathin-captan
Alternaria Leaf Spot Greasey Blotch	Carnations	zineb captan
Rhizoctonia Stem Rot	Carnations	quinotozene carbathin-captan
Leaf Spot	Chrysanthemum	captan zineb
Root rot	Chrysanthemum Lily	fenaminosulf ethazole carbathin-captan
Stem Rot	Cineraria	fenaminosulf ethazole quintozene carbathin-captan

Appendix X (cont'd.)

Root Rot (Cuttings)	Foliage Plants	captan fenaminosulf ethazole benomyl carbathin-captan
Botrytis	Geranium	benomyl dichloran chlorothalonil captan iprodione
Root, stem, crown and tuber rot	Gloxinia	fenaminosulf ethazole carbathin-captan
Root rot	Hydrangia	fenaminosulf quintozene ethazole carbathin-captan
Root Rot	Poinsetta	fenaminosulf quintozene ethazole benomyl carbathin-captan
Black Spot	Rose	benomyl captan zineb

APPENDIX XI Commercial Production of Annuals and Perennials

Disease	Host Plant	Control	Remarks
Botrytis Botrytis leaf spot Fire (Botrytis)	Pansy *(Viola)*, Snapdragon, Geranium *(Pelargonium)*. Spring flowering bulbs	zineb maneb captan thiophanate-methyl iprodione	
Gray mould (Botrytis)	Chrysanthemum	zineb captan ferbam	
Leafspot	Begonia, Coleus, Impatiens, Marigold *(Tagetes)*, Salvia, Chrysanthemum, Campanula, Delphinium Hollyhock *(Althea)*, Iris, Phlox	zineb maneb captan thiophanate-methyl	
Rust	Ageratum, Centaurea, Cineraria, China Aster *(Callestephus)*, Dusty Miller, Pansy *(Viola)*, Salvia, Columbine *(Aquilegia)*, Campanula, Chrysanthemum, Hollyhock *(Althea)*, Iris, Primula	captan ferbam zineb	
Scab	Pansy *(Viola)*	zineb maneb captan	
Stem rot	Begonia	zineb captan	Use as a soil drench.

APPENDIX XII Commercial Production of Trees and Shrubs (Ornamentals)

Host Plant	Disease	Control	Remarks
Apple *(Malus)* Firethorn *(Pyracantha)* Hawthorn *(Crataegus)* Mountain Ash *(Sorbus)*	Scab	dodine benomyl, plus mancozeb metiram captan	
Catalpa *(Catalpa)* Hawthorn *(Crataegus)* Hickory *(Carya)* Horse-chestnut *(Aesculus)* Maple *(Acer)* Mountain Ash *(Sorbus)* Oak *(Quercus)* Poplar & Aspen *(Populus)* Walnut *(Juglans)*	Leafspot	zineb maneb captan thiophanate-methyl	Up to 3 or more applications may be necessary depending on persistence of cool, wet weather - first as leaves are unfolding and thereafter at 7 to 10-day intervals as required.
Cherry, Peach Flowering Almond *(Prunus)*	Blossom and twig blight	sulfur captan dodine benomyl, plus mancozeb	Spray just before blossom buds open. Repeat in 10 days if wet weather persists.

APPENDIX XIII HOME GARDENS

Control of Diseases on Vegetables

Kind of Vegetables	Diseases	Treatments
Many Vegetables	Damping off	Seedling treatment or soil drench with captan or oxine benzoate
	Seed borne diseases	Seed treatment: captan
Carrot	Leaf spots and blight	Three treatments, starting late July and 3 applications at 7 day intervals. captan chlorothalonil maneb

APPENDIX XIV HOME GARDENS

SPRAY PROGRAM FOR APPLE AND PEAR

Time to Spray	Pests to Control	Pesticides to use	Remarks
When buds break until open flower bud cluster	Scab	Use one of: benomyl captan ferbam	Sprays may be required weekly during this time if prolonged wet periods occur. Do not apply captan if dormant spray oil was applied. Do not use benomyl on pear.
From pink flower buds until first open blossoms	Scab	Same as above	
When flower petals fall	Scab	Use one of: benomyl captan ferbam	Do not use benomyl on pear.
12 days after petals fall and repeat at 12 to 14 day intervals until about mid-August	Scab	Use one of: benomyl captan ferbam	Do not use benomyl on pear.

RESISTANCE TO CERTAIN FUNGICIDES

By using a single "systemic" fungicide, such as benomyl, exclusively to control a certain disease, the fungus may become resistant to this fungicide. By alternating a "systemic" fungicide with a recommended "non-systemic" fungicide, such as captan, the development of resistance can be avoided or delayed.

APPENDIX XV HOME GARDENS

SPRAY PROGRAM FOR PEACH, PLUM AND CHERRY

Time to Spray	Pests to Control	Pesticides to Use	Remarks
When flower petals fall	Leaf spot Brown rot	Use one of: benomyl captan ferbam	Leaf spot is not a problem on peach. On plum and cherry, use captan or ferbam if leaf spot is serious
10 days later	Leaf spot Brown rot	Same as above	
July 1-10	Leaf spot Brown rot	Use one of: benomyl captan ferbam	Dates for this and following sprays are only approximate, depending on geographic location.
July 15-30	Leaf spot Brown rot	Same as above	
Later sprays	Leaf spot Brown rot	Same as above	On cherry, apply only fungicide for leaf spot after harvest. Plums and peaches may require an extra spray for brown rot before harvest.

RESISTANCE TO BENOMYL FUNGICIDE

By using benomyl exclusively to control a certain disease, the fungus may become resistant to this fungicide with the result that it loses its effectiveness. By alternating with captan, the development of resistance can be avoided or delayed.

APPENDIX XVI HOME GARDENS

CONTROL OF DISEASES ON FRUIT

Kind of Fruit	Diseases and Treatments	Use One of these Fungicides if Necessary
Grape	Downy mildew: Spray just before bloom but after flower clusters have expanded; additional sprays may be necessary depending on weather and disease conditions.	captan copper folpet
Raspberry	Anthracnose and spur blight: After harvest cut out old canes and diseased young canes. Discard all removed canes. Spray lime sulfur when leaf buds are breaking in spring and leaflets are 1/2 to 1 cm long. Then spray captan when the new shoots are 15 to 20 cm tall, again when they are 30 to 40 cm tall and repeat 2 weeks later. Spray thoroughly.	lime sulfur captan
	Fruit rot: Spray between blossoming and harvest if fruit rot was a problem during earlier years and weather is wet. Repeat at about 10-day intervals	benomyl captan
Strawberry	Fruit rot or gray mold: Start spraying just before first blossoms open, and repeat at weekly intervals until end of harvest.	benomyl captan
	Leaf spot: When planting, trim off diseased leaves. Spray 1 month later and repeat twice at 14-day intervals.	captan

APPENDIX XVII HOME GARDENS

CONTROL OF DISEASES ON ORNAMENTAL PLANTS

Disease	Description and Treatment	Use One of these Fungicides if Necessary
Black Spot	Roses: During summer, starting when buds burst until foliage is killed by frost, spray or dust every 7 days in periods of rain or heavy dew or repeated watering, especially when growth is rapid. During dry periods spray or dust every 14 days. Be sure that underside of leaves is covered by spray or dust.	benomyl captan chlorothalonil dichlone dodine folpet mancozeb triforine
Leaf Blight (Anthracnose) of maples and other trees Leaf Scorch of horse-chestnut Leaf Spot of catalpa	Diseases affect maples, London plane tree, sycamore, ash, oak, hawthorn, horse-chestnut and catalpa in early spring from spores released from fallen leaves of previous year. It is helpful to remove all fallen leaves. Trees which are affected in successive years become weakened and branches gradually die. If necessary, spray when buds break and repeat twice at 2-week intervals. Spraying in midsummer is useless.	captan
Leaf Spot of herbaceous perennials and annuals	Leaf spots can affect begonia, coleus, impatiens, marigold, salvia, chrysanthemum, delphinium, zinnia, iris and phlox. Promote quick drying of foliage by adequate spacing, removal of weeds and avoiding watering in the evening. Spray or dust when the first leaf spots show.	benomyl captan folpet mancozeb
Scab	Crab apple and fire thorn: Resistant varieties of fire thorn are available. Spray when first leaf buds break and repeat at 7 to 10 day intervals during May and June, particularly during rainy periods. Dusting is not very effective.	benomyl captan lime sulfur (on crab apple only)

OVERVIEW OF I.B.T. ISSUE

BACKGROUND:

Approximately four years ago it was discovered that there were irregularities in certain reports of animal studies conducted for chemical manufacturers by Industrial Biotest Laboratories (I.B.T.). These raised questions concerning the validity of the toxicological tests carried out by this laboratory. Since these studies formed part of the data assessing the safety of these pesticides, a moratorium was placed on the use of I.B.T. data to support the registration of new or expanded uses of about 100 pesticides.

The pesticide manufacturers, in conjunction with the U.S. Environmental Protection Agency (E.P.A.), Health and Welfare Canada and Agriculture Canada, have been carefully and thoroughly reviewing all of the available data for health and safety impact. During the course of this review, very little information, other than a listing of the compounds involved, was released by the Federal government.

Ontario and other provinces repeatedly requested more information but were denied this based on the legal opinion of the Federal Department of Justice. Federal Ministers Begin and Whelan were advised that all data and studies submitted in support of registration were confidential, and therefore not available to the provinces or the public. Furthermore, Begin repeatedly stated "that there is no definitive evidence of any potential health hazard that would necessitate, at this time, further restriction in the registration and use of these pesticides".

In April, 1981 Health and Welfare Canada released information concerning the I.B.T. status of 79 compounds, the test having been already cleared. Compounds were placed in one of four (4) categories according to the extent and importance of I.B.T. invalid studies. The main concern is the Category 1 compounds, those pesticides heavily supported by I.B.T. studies and, therefore, with major deficiencies in their toxicological data. The total number of category 1 compounds is 37.

The Ontario Pesticides Advisory Committee (OPAC) contacted registrants regarding the 37 category 1 compounds, since Federal Authorities refused to provide further information on them. Company representatives were asked whether or not they planned to defend their compounds and, if so, whether they would be willing to provide information on the nature, number and completion dates of replacement studies required. On August 6th, 1981, OPAC submitted its review paper entitled "Review of I.B.T. Implicated Pesticides" to the Minister. The Committee's recommendations were to take no action on the 37 compounds, other than rescheduling certain commercial products without domestic labels to better reflect their use pattern. The Committee recommended that the I.B.T. situation be closely monitored and all new information be assessed. The Ministry of the Environment studied the Federal categories and rescheduled 106 pesticide products containing thirty-eight active ingredients. The rationale for this action is explained in the attached factsheet entitled "Pesticides and Industrial Biotest Laboratories". This factsheet has been disseminated to licences under the Pesticides Act and to individuals inquiring about the I.B.T. situation. Also, appropriate explanations of the I.B.T. pesticides has been included in the recommendation calendars of the Ontario Ministry of Agriculture and Food. In particular, the safety percautions listed on pages 2 and 3 of the factsheet have been highlighted.

FACTS

about pesticides

Ontario

Ministry
of the
Environment

Hon. Keith C. Norton, Q.C.
Minister

Gérard J. M. Raymond
Deputy Minister

NUMBER: 20-01-04
DATE : REVISED NOVEMBER, 1981

PESTICIDES AND INDUSTRIAL BIOTEST LABORATORIES

Following the discovery that there were irregularities in some toxicological animal tests conducted by Industrial Biotest Laboratories (I.B.T.) for the registration of pesticides, the data from all I.B.T. studies was reviewed for acceptability. Use of I.B.T. data to support the registration of pesticides for new or expanded uses was suspended pending validation.

The review of data for acceptability has been substantially completed by Health and Welfare Canada and Agriculture Canada in co-operation with US Environmental Protection Agency. Replacement studies are being conducted by pesticide manufacturers, and are in various stages of completion. Some of these studies have been submitted to Health and Welfare Canada for evaluation. On the basis of these reviews, Health and Welfare Canada has determined the significance of the irregularities and has grouped pesticides accordingly.

The Ministry of the Environment has studied the Federal categories and has rescheduled thirty-three pesticide products containing the following eight active ingredients into Schedule 1 under the Pesticides Act, 1973, thereby limiting availability to licenced pesticide applicators and agriculturists and requiring specific use permits.

ACTIVE INGREDIENT	SAMPLE TRADE NAME
allidochlor	Randox
binapacryl	Morocide
chlorbromuron	Maloran
cyprazine	Outfox
nicotine sulphate	Nicotine
phosphamidon	Dimecron
sodium chlorate	Atlacide
tetradifon	Tedion

This action is based on the fact that registrants do not intend to replace invalid I.B.T. studies for these compounds. The Ministry will identify the registered, essential uses of these pesticides and will develop product specific policies for the issuance of permits.

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Thirty other active ingredients still have major data gaps because of invalid I.B.T. studies. To ensure that the use of commercially labelled pesticides containing these active ingredients is limited to licenced pesticide applicators and agriculturists, seventy-three such products were rescheduled to Schedule 2. The active ingredients are:

HERBICIDES

ACTIVE INGREDIENT	SAMPLE TRADE NAME
alachlor	Lasso
barban	Carbyne
chlorpropham	CIPC
cyanazine	Bladex
metobromuron	Patoran
metolachlor	Dual
metribuzin	Sencor
paraquat	Gramoxone
picloram	Tordon
propham	IPC
simazine	Princep
terbuthylazine	Topoguard
Triallate	Avadex BW

INSECTICIDES

ACTIVE INGREDIENT	SAMPLE TRADE NAME
acephate	Orthene
carbofuran	Furadan
coumaphos	Co-Ral
disulfoton	Di-Syston
endosulfan	Thiodan
ethion	Ethion
fensulfothion	Dasanit
methamidophos	Monitor
methidathion	Supracide
naled	Dibrom
phenothrin	Sumithrin
tetrachlorvinphos	Gardona
toxaphene	Toxaphene

FUNGICIDES

ACTIVE INGREDIENT	SAMPLE TRADE NAME
captafol	Difolatan
captan	Captan
folpet	Phaltan
metiram	Polyram

Replacement studies for these active ingredients are in progress or under evaluation. Meanwhile, the Ministry recommends that persons handling and applying these chemicals exercise all safety precautions. The Ministry is so notifying all licencees under the Pesticides Act, 1973.

The following safety precautions should be followed at all times:

1. Always read the label before opening pesticide containers and follow all precautions and directions. Pay particular attention to advice concerning masks, respirators and other protective clothing.

2. Never smoke, chew tobacco or eat while handling or applying pesticides. DO NOT carry such items in clothes used for spraying.

3. Always wear neoprene gloves to handle the concentrate. Wear a mask especially when handling dusty formulations to reduce inhalation. Avoid inhaling spray droplets, dust or fumes.

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4. Avoid spilling pesticides on skin. If an accident occurs wash contaminated skin thoroughly with soap and water. If clothing does become wet with a pesticide, remove it immediately and wash it as soon as possible.

5 Immediately after spraying, remove protective clothes, have a bath or shower and put on freshly laundered clothing. Wear freshly laundered clothes each day.

6. Clean up any pesticide spill immediately. Use dry soil or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Section, Ministry of Environment for advice.

7. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to hospital immediately. If possible, take a labelled container of the pesticide with you. (See Emergency Procedures for Pesticide Poisoning in OMAF Pesticide Publications e.g. #64, #75).

8. Avoid contaminating water supplies, wells, ponds, streams, etc. when filling or flushing out spray equipment. Never fill a sprayer directly from a stream or pond unless the unit is equipped with an antisiphoning device to prevent backflow.

There are about forty active ingredients, in addition to those mentioned above, that have been implicated with I.B.T. These pesticides have not been listed here because either the I.B.T. involvement in their registration was minor or replacement studies conducted by other laboratories are available and are being reviewed by Federal authorities.

This situation is dynamic and will change with new technical information, and Federal policies. Ongoing assessments will likely require further provincial action.

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Assessment of captan /

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